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THE CONDOR

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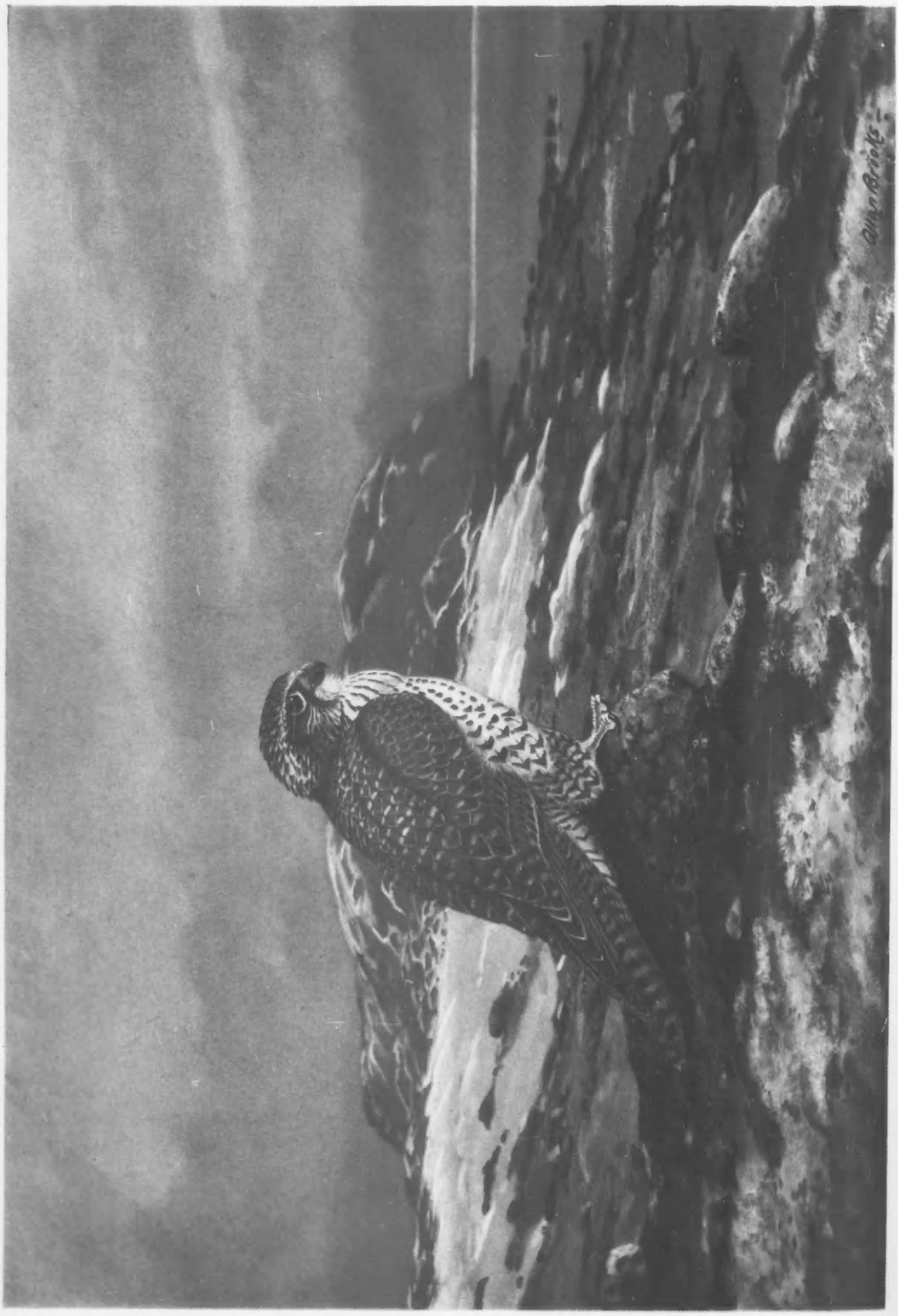

THE CONDOR

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NATURAL HISTORY AND DIFFERENTIATION IN THE YELLOW-BELLIED SAPSUCKER

By THOMAS R. HOWELL

INTRODUCTION

The Yellow-bellied Sapsucker (*Sphyrapicus varius*) is a species of woodpecker subdivided into strongly characterized geographic races that are clearly distinguishable even in the field and which differ markedly in the extent of interbreeding where their ranges meet. The purpose of this investigation has been the analysis of the differentiation in the group as it approaches the species level.

Between some races of sapsuckers there is free interbreeding, whereas between others it is so rare that reproductive isolation is almost complete, even though physical and ecological barriers, if present, seem no greater than where intermixture takes place. The species is also peculiar in that sexual dimorphism in color is distinct in one race whereas it is completely lacking in another. Similarly, the races vary from highly migratory to practically sedentary. These rather unusual features, coupled with the fact that most of the zones of contact are limited and relatively accessible, make the Yellow-bellied Sapsuckers an excellent subject for the study of morphological variation in combination with field studies on the breeding behavior of the races at the points of junction. The latter topic was especially emphasized, for despite the fact that specimens showing intermediate characters have been known for almost a hundred years, no mixed pairs had ever been reported and no data published on the viability and fertility of the intermediates. I have also attempted, insofar as the meager evidence permits, to determine the genetic, environmental, and historical factors which may have influenced the evolution of the forms within this group.

MATERIALS AND METHODS

To obtain data on breeding behavior in zones of contact and overlap, field trips were made to selected areas in northern California in 1948 and 1949 and to British Columbia in 1950. I spent five days, from May 20 to May 24, 1948, in the vicinity of Canby, Modoc County, California, and in 1949 stayed for about six and one-half weeks, from May 21 to July 4, at Crowder Flat, 38 miles northwest of Alturas, Modoc County, California. From April 27 to July 14, 1950, I visited various localities in British Columbia, spending most of the time in the region between Hope and Princeton and between Williams Lake and Quesnel. In these periods I was able to observe stages in the life history of the birds from pre-nesting territorial behavior through the emergence of the young from the nest. Sapsuckers were collected at all the localities mentioned except Manning Provincial Park in the Hope-Princeton area. They are deposited in the Museum of Vertebrate Zoology.

Additionally, specimens have been examined from the following institutions and collections: The Donald R. Dickey Collection and the Department of Zoology Collection, University of California, Los Angeles (UCLA); the Los Angeles County Museum, Los Angeles (LACM), through Mr. Kenneth E. Stager and Mr. William G. Reeder; the

Robert T. Moore Collection, Pasadena, California (RTM), through Dr. Moore and Dr. John Davis; the United States National Museum, Washington, D.C. (USNM), through Mr. H. G. Deignan; the Allan R. Phillips Collection, Tucson, Arizona (ARP), through Dr. Phillips. A total of approximately 1040 specimens was examined, mostly from the California institutions.

ACKNOWLEDGMENTS

I wish to express sincere thanks to the people and institutions just mentioned for their generous cooperation and assistance. I also wish to thank Mr. W. Earl Godfrey of the National Museum of Canada for information on sapsuckers in that collection; Dr. George A. Bartholomew, Jr., and Dr. Daniel I. Axelrod of the University of California, Los Angeles, for suggestions and advice; Dr. Ian McT. Cowan of the University of British Columbia for his invaluable assistance in planning field studies in Canada; Mr. R. F. Boyd, Ranger of E. C. Manning Provincial Park, British Columbia, for much useful information on that region; Mr. Jesse M. Drake of the U. S. Forest Service, Canby, California, Mr. and Mrs. William Hillem of Quesnel, British Columbia, and Mr. and Mrs. Ronald H. Moffitt of Alexandria, British Columbia, all of whom generously gave assistance without which the field work could not have been accomplished. Finally, I wish to thank especially Dr. Alden H. Miller for his unfailing interest and guidance during the entire course of this study.

THE GENUS AND SPECIES

The genus *Sphyrapicus* differs strikingly from other genera of woodpeckers in its feeding habits and the associated structural modifications. Sapsuckers rarely if ever dig into infested trees for woodboring insects and larvae but feed to a considerable extent on the cambium and softer parts under the bark of trees and shrubs and on the sap as well. They do this by drilling rows of holes through the outer bark or by removing it over a long strip. The diet also includes fruits and berries and many insects; the latter may be caught on the wing or gathered from tree trunks, branches, and the sap workings. Detailed accounts are given in McAtee (1911), and Grinnell and Storer (1924).

In relation to these feeding habits, the tongue is brushy or bristled at the tip rather than barbed, and it is much less extensile than in other genera of woodpeckers. The hyoid elements are less elongated than in other picids and do not extend over the crown; the capital apterium is correspondingly small. For details of tongue structure and pterylosis see Lucas (1895), Coues (1903), and Burt (1929); for a complete listing of generic characters see Coues (1903) and Ridgway (1914).

The breeding range of the genus is restricted to North America north of México; some races migrate south of the border, and one goes as far as Panamá and the West Indies. Two species are currently recognized by most authors. *Sphyrapicus thyroideus* is a well-marked form divided into two subspecies, *S. t. thyroideus* and *S. t. nataliae,* and is of only incidental importance in this report. The other species, *Sphyrapicus varius,* is the one on which the present study is based.

Sphyrapicus varius is now considered by most authors to be a polytypic species comprising four well-characterized subspecies, although the group has frequently been divided into two species with each one including two races. Oberholser (1938) has proposed that the eastern form be split into northern and southern subspecies, *S. v. atrothorax,* and *S. v. varius,* respectively, on the basis of size; however, this procedure has not been followed by most taxonomists (Wetmore, 1940), and the question of its validity is outside the scope of the present study. In this paper I have followed the current nomenclature in recognizing four races of one species, for reasons which will be discussed

later. A synonymy of earlier names may be found in Ridgway (1914), and the basis for adoption of those presently in use may be found in Swarth (1912). The four races are *S. v. varius, S. v. nuchalis, S. v. daggetti,* and *S. v. ruber.*

Detailed descriptions of the forms may be found in Ridgway (1914), and descriptions of juvenal plumage and molt sequence appear in Bent (1939). The following accounts of the characteristics of the races have been condensed from these sources and have been modified from them by checking against large series of specimens.

SYNOPSIS OF RACES

Sphyrapicus varius varius (Linnaeus)

Adult male.—Forehead and crown bright poppy red or crimson, bordered posteriorly by an occipital crescent of glossy blue-black, extending laterally to above middle of eye; nape white or brownish white, rarely tinged lightly with red, laterally confluent with white postocular stripe; auricular region glossy black; a broad band of white originates at nasal tuft and extends between orbital and malar region to side of neck; malar stripe black, becoming narrow posteriorly where it joins a large patch of glossy blue-black, strongly convex posteriorly, extending across jugulum; chin and throat bright poppy red, like crown; median underparts and sides of jugulum white tinged with primrose yellow, more strongly so in fresh plumage; sides and flanks dull white or brownish white, broken by streaks and V-shaped markings of blackish; back and scapulars black heavily spotted with white, especially on sides of back; rump and upper tail coverts mostly black laterally, mostly white medially; wings black, with exposed portion of middle coverts and outer web of greater coverts except proximal ones white, forming a conspicuous longitudinal white patch along anterior part of wing; outer webs of primaries with large elongated spots of white, proximal portions of inner webs of primaries, including rudimentary outermost, with elongated white spots; secondaries and tertials much spotted with white on both webs distally; tail black, with inner web of middle pair of rectrices heavily barred with white or mostly white, the lateralmost with white spots on outer or both outer and inner webs in about half the cases.

Adult female.—Similar to adult male, but with a white instead of red chin and throat; red on crown varies from somewhat less posteriorly to lacking altogether; white spotting generally heavier, always present on one or both webs of outermost pair of rectrices.

Juvenile (sexes alike).—Wings and tail as in adults; back similar but washed with yellowish brown; sides and flanks similar, but more brownish; median underparts tinged with yellow; head region notably different from adults in that red and black areas are lacking; pileum sooty brown, each feather with a small, lighter-colored terminal or subterminal spot; auricular region and malar stripe brownish, the former with light shaft-streaks; stripes on sides of head dull white instead of clear white as in adult; chin dull white shading to pale buffy brown on throat; jugulum pale brown marked with fine crescentic bars of dusky, not strongly demarcated from adjacent areas.

The juvenal plumage is replaced gradually by protracted partial molt, at least of the body feathers. Red feathers may appear in the young males shortly after they leave the nest, and usually before any black feathers appear in the head region. Females may be much slower in acquiring the red crown. By late spring the adult plumage is almost always complete, but the black feathers of the jugulum may have light buffy edgings which disappear later through wear. In all the races the feathers of the jugulum appear to be the last to be replaced.

Adults have a prenuptial molt about the head and throat early in spring and a complete molt in late summer and fall (Bent, 1939). In fresh fall plumage, the lighter markings of the body are suffused with yellowish, and the belly is deeper yellow. A few narrow buffy edgings may be present on the feathers of the jugulum.

Occurrence.—S. v. varius breeds in deciduous or mixed deciduous and coniferous forest of eastern and northern parts of the continent, especially that including *Populus* (poplar, aspen, cottonwood, etc.) and *Betula* (birch). For geographic range see maps (figs. 1, 2).

In winter it occurs in a variety of forest associations from latitude 40° south to Panamá and the Greater Antilles. It is accidental in Greenland, Bermuda, Wyoming, Colorado, Arizona, and California. Wintering intermediates between this race and *S. v. nuchalis* have been taken at San Antonio, Bexar

County, Texas (USNM no. 112922) and 1 mile north of Tapalpa, Jalisco, México (RTM no. 27012).

Spring migration begins at least by the last week of March and may continue until the first week of May. Fall migration begins as early as the latter part of August and may continue into early November.

Fig. 1. Approximate outlines of breeding ranges of the four subspecies of Yellow-bellied Sapsucker (*Sphyrapicus varius*).

Sphyrapicus varius nuchalis Baird

Adult male.—Similar to *S. v. varius,* but with much less white on back, this usually forming two definite but broken stripes laterally, converging posteriorly; nape red instead of white; red of throat more extensive, covering posterior portion of malar stripe and extreme upper part of jugulum; auricular region frequently tinged with red; white spots on outermost pair of rectrices almost always lacking; underparts usually less yellowish than in *S. v. varius.*

Adult female.—Similar to adult male, but chin and sometimes upper throat white, rarely almost completely red, the red not extending over malar stripe or tinging auricular region; facial striping may be less sharply defined than in male; white spots on outer web of outermost rectrix almost always present; crown always red, never largely or completely black as is sometimes true in *S. v. varius.*

Juvenile.—Similar to *S. v. varius,* but darker and less brown; pileum uniform sooty slate, unspotted, sometimes washed with brown; white of back less brownish; underparts less yellowish; dark markings of head more blackish; jugulum brownish gray, the dusky barring less apparent because of the darker background; chin and throat darker than in *S. v. varius.* Molt is apparently as in *S. v. varius,* but adult plumage is sometimes attained by late fall and always by early spring at the latest.

Remarks.—In very rare instances the red of the nape is lacking. An occasional juvenal *S. v. nuchalis*

is pale enough to be indistinguishable from a dark juvenal *S. v. varius*. An adult male from 17.5 miles south of Quesnel, British Columbia, lacks the white postocular stripe and is black in this area; another male from Alexandria, 28 miles south of Quesnel, has this white stripe reduced to a very narrow streak.

Occurrence.—*S. v. nuchalis* breeds primarily in forests containing aspen (*Populus tremuloides*) in pure stands or mixed with conifers; more rarely, it breeds in predominantly coniferous growth. It does not breed in oak (*Quercus*) woodland or mixed oak and pine forests. Its breeding range is primarily the Rocky Mountain region. It also breeds across southeastern British Columbia (chiefly east of the Fraser River) from the vicinity of Williams Lake south to the east slope of the Cascade Mountains and along the east side of this range to extreme northeastern California, between the Rocky Mountains and the Sierra-Cascade Range wherever suitable habitats are found, and at a few localities along the east slope of the Sierra Nevada in east-central California and extreme west-central Nevada.

Nuchalis winters in a variety of forest associations at low elevations in the southern part of its breeding range and farther south (see fig. 2). It is casual in Kansas, Nebraska, and Oklahoma and accidental in Guatemala. Wintering intermediates between this race and *S. v. daggetti* have been taken in Arizona, Sonora, southern California, and on Santa Cruz Island, California (LACM no. 2893), and a specimen from Crescent City, Del Norte County, California, taken November 29, 1915 (UCLA no. 24856) is almost certainly a *nuchalis* x *ruber* intermediate.

Spring migration begins at least by the last week of March and may continue until about the latter part of April. Fall migration probably begins about the first part of September and may continue throughout October.

Sphyrapicus varius daggetti Grinnell

Adult male.—Basically similar to *S. v. nuchalis,* but with much more red; nasal tufts and anterior and lower portion of lores dull yellowish white; posterior portion of lores and antero-inferior half of orbital ring black; frequently a small spot of white at upper posterior edge of ring; rest of head, neck, and chest bright red superficially, sometimes extending over breast and half-way down sides. The pattern of black and white markings on the head which is found in the two previously described races is still present, although much less distinct, on the subterminal parts of the feathers; the markings show faintly through the overlying red. White of back as in *S. v. nuchalis* or slightly less; abdomen yellowish white, more yellowish in fresh plumage; wings as in *S. v. nuchalis,* but white spots on rudimentary outermost primary frequently lacking; tail as in *S. v. nuchalis* but without white spots in outermost rectrices.

Adult female.—Like adult male, and indistinguishable in the field; rudimentary outermost primary usually with white spots; outermost pair of rectrices with white spots on outer web in about half the cases; white postocular spot of more frequent occurrence than in male.

Juvenile.—Somewhat similar to *S. v. nuchalis,* but head, neck, and breast much darker sooty, with no whitish markings except a dull white loral streak and frequently a dull white postocular spot; dark barring on breast obscure; pileum, throat, and breast frequently washed with reddish. Molt into adult plumage seems to be completed at least by early spring and often by late fall. There is a complete molt in late summer and fall in the adults; no prenuptial molt is known.

Occurrence.—In all but the coastal part of its range, *S. v. daggetti* breeds primarly in an aspen-ponderosa pine (*Pinus ponderosa*) association; on the coast, it inhabits the predominantly coniferous forest of this humid region. Like *S. v. nuchalis, daggetti* does not breed in oak or oak-pine woodland. The breeding range of this race is primarily from the Cascade Mountains of southern Oregon (Klamath County) and the Sierra Nevada in California and Nevada west across northern California to the coast (fig. 1). In extreme southern Oregon it intergrades completely with *S. v. ruber*.

S. v. daggetti winters chiefly west of the Sierra Nevada in a variety of forest associations at low elevations throughout most of its breeding range, in suitable areas in the interior, along the entire coast of California, and south to about latitude 30° in Baja California. It is casual on the Santa Barbara Islands off the southern California coast and accidental in Arizona.

Migration in the spring and fall is not extensive, but the times of such movements are apparently similar to those of *S. v. nuchalis,* although probably of shorter duration.

Remarks.—The shade of red in the adults varies from dull in fresh fall plumage through bright red in the spring to an orange red, at least in part, in late summer before the annual molt. This color change is brought about by a process of wear which will be discussed briefly in a following section.

Fig. 2. Approximate outlines of winter ranges of the four subspecies of Yellow-bellied Sapsucker. The dark area in southern California represents overlapping of ranges of *nuchalis* and *daggetti*.

Sphyrapicus varius ruber (Gmelin)

Adults (sexes alike).—Similar to *S. v. daggetti* but slightly larger and darker, red deeper and brighter, black more extensive; white of back usually restricted to two obscure and narrow broken stripes, frequently tinged with yellow; with very rare exceptions no white spots on rudimentary outermost primaries or on outermost pair of rectrices; white spots on other wing feathers fewer and smaller; red frequently more extensive, sometimes reaching down onto abdomen; median underparts deeper yellow than in *S. v. daggetti*; underlying black and white pattern of head and neck very obscure.

Juvenile.—Similar to *S. v. daggetti*, but much blacker, especially about head and neck; no trace of the striping present in *S. v. varius* and *S. v. nuchalis*. Molt into adult plumage is complete at least by early spring, usually by late fall or winter; other molts apparently as in *S. v. daggetti*.

Remarks.—In fresh fall plumage, the red is darker and duller than later in the year, as is true in *S. v. daggetti* but not in *S. v. varius* and *S. v. nuchalis*.

Occurrence.—*S. v. ruber* breeds in the humid coast forest of the Pacific Northwest from southeastern Alaska to southern Oregon. It also breeds in the mixed deciduous and coniferous forests along the west slope of the Cascade Range, occasionally east of it in Oregon (Deschutes County) and Washington (Yakima County), and in the central interior of British Columbia from Doch-da-on (=Dokdaon) Creek to the Peace River district (Tupper Creek) and south to Indianpoint Lake, the vicinity of Quesnel, and probably Lillooet.

This race winters in the coastal part of its breeding range, at least as far north as Prince of Wales Island, Alaska, and possibly even farther north.

Spring migration into the interior of British Columbia begins at least by the first week of April; the time of fall migration to the coast is not known.

A specimen from Arizona taken on October 27, 1932 (Godfrey, 1944) is close to typical *ruber* but appears to have traces of *nuchalis* characters in that it shows the underlying head and breast pattern more distinctly than is usual in *ruber*. This specimen is almost perfectly matched by one taken on November 24, 1926, at Tillamook, Oregon (UCLA no. 26441); both are probably *ruber* slightly approaching *nuchalis*. Such a mixed ancestry might account for the long migration of the Arizona bird, as *nuchalis* is of frequent occurrence as a migrant in the southwestern United States.

PIGMENTATION

One of the most noticeable features of the bright red feathers of sapsuckers and other woodpeckers is the polished, waxy luster and the loose, somewhat hairy texture. In such feathers the entire barbs or only their distal parts are enlarged both in length and diameter, devoid of barbules, and packed with pigment. This has been pointed out briefly and succinctly by Chandler (1916), and in detail by Frank (1939). In most cases the barbules are minute or absent even when the feather is just breaking out of its sheath, but in *Sphyrapicus varius daggetti* and *S. v. ruber* the red barbs bear numerous blackish barbules when freshly erupted. This causes the dullness of their red feathers in early fall which was mentioned in the foregoing descriptions of these races. The barbules are apparently fragile, for they soon wear off and leave the barbs with the gloss and loose texture which is present most of the year. Severe abrasion of the feathers during nesting activities results in a lightening of the red until it appears almost orange in some parts. In feathers which are parti-colored, or even in individual barbs which are part red and part black, the red area lacks barbules and the non-red region has them. Interestingly, the black malar feathers of the males of the Yellow-shafted Flicker (*Colaptes auratus*) have naked barbs distally and Test (1942) has shown they contain red pigment which is masked by black.

Another unusual aspect of red coloration in sapsuckers is that it is largely superficial in position; the red is present only as an extensive tipping to the feathers. When no red is present in the adult, as in some females of *S. v. varius*, this reveals the basic black and white pattern on which in other plumages red is superimposed. If red tips were added to the black feathers of the pileum of such an individual, proceeding from anterior to posterior, the other plumages of the adult female *S. v. varius* would be attained. If red tips were added to the white throat feathers, the plumage of the male *S. v. varius* would be approximated. Then, if the white nape and the black malar stripe and perhaps part of the auriculars were tipped with red, the plumage would resemble that of the male *S. v. nuchalis*. A little less red tipping on the face and throat would approach the pattern of the female *S. v. nuchalis*. If the entire head, neck, and upper breast were red-tipped and the underlying black and white pattern made duller and less well defined, the result would simulate *S. v. daggetti*. If the underlying pattern were still more obscured, the coloration would be like *S. v. ruber*. Or, to put it another way, if all the red tips were trimmed from any adult plumage of any race of *S. varius*, a pattern similar to that of a non-red female *S. v. varius* would be revealed.

Although the extremes in color are connected in a gradual transition in an appropriate series of specimens, as pointed out over seventy-five years ago by Baird, Brewer and Ridgway (1874), the color variation is not arranged along a smooth gradient. Variation in one race never produces an individual with all the characters of another, and it is only in specimens from the usually narrow zones of intergradation that the bridging of the gaps may be seen. The additional fact that the juveniles of each race are also distinct,

with patterns corresponding to those found in the adults, indicates that the color differences are deeply-rooted characteristics.

As red coloration in the sapsuckers is important both in sexual and racial distinctions, it may be useful at this point to review briefly the nature of this type of pigmentation. In birds, almost all the brilliant red, orange, and yellow pigments which have been chemically analyzed are found to be carotenoids. Turacin, the purplish red pigment found in the Musophagidae, is the only exception. Reddish brown or rusty colors are often referred to as red, especially in domestic fowl and laboratory animals, but these pigments are melanins and are not to be confused with the bright red carotenoids. A detailed discussion of the chemical nature of the carotenoids is presented by Bogert (1938); for present purposes it is sufficient to note that these pigments are polyene hydrocarbons, alcohols, and ketones. They may be extracted with fat solvents and hence are included among the lipochromes.

Carotenoids have been identified in various members of the Picidae by Brockmann and Völker (1934), Völker (1939), Test (1942), and Kritzler (1943). Although the red pigments of sapsuckers have never been analyzed to my knowledge, there is every reason to suppose that they too are carotenoids and probably are quite similar to those in the other woodpeckers.

Birds have never been shown to be capable of synthesizing the carotenoid pigments, and there is abundant evidence that they must be acquired from plant sources in the diet. On the whole, however, the process of carotenoid pigmentation from ingestion to deposition in the feather is poorly known.

Most woodpeckers show sexual dimorphism in color, and it is almost always manifested by the presence or greater extent of carotenoid color, especially red, in the male. *S. v. daggetti, S. v. ruber, Melanerpes erythrocephalus,* and *Asyndesmus lewis* are the only North American picids in which the plumage of the sexes is not distinguishable with certainty; *S. v. varius* and *S. v. nuchalis* fit the more usual pattern. The fact that in some picids carotenoid colors may appear in the adult males and juveniles of both sexes but not in the adult females suggests the influence of sex hormones, and it has been thought that carotenoid coloration in these species is correlated with a low concentration of estrogens. However, this seems to be disproven in the case of *Dendrocopos major* by the experiments of Nowikow (1939). He found that castration, ovariotomy, and injection of follicular hormones had no effect on the red in the plumage of juveniles or adults of either sex. It is likely that the same results would be obtained in other members of this closely-knit genus and in *Sphyrapicus varius* as well, since the sexes are alike in the early juvenal plumage of all four races and in the adults of two. With the exception of minor changes caused by wear, the sapsuckers show no seasonal differences in color such as are often found in birds with hormonal control of pigmentation. What evidence there is, as given above, suggests that in the sapsuckers the differences in carotenoid color between the sexes and the races are caused by genetic differences which are not influenced by the endocrine system.

Differences between the sexes and the races in melanin pigmentation are slight but follow the same trends as those in carotenoid pigmentation, that is, there is a progressive increase in extent of melanin pigmentation of the body, wings, and tail from *S. v. varius* to *S. v. nuchalis* to *S. v. daggetti,* and a progressive decrease in color difference between the sexes. In *S. v. ruber,* the sexes are equally dark. Although in these birds both pigment types vary similarly, it is probable that the melanins and carotenoids change independently of one another.

Consideration of albinistic woodpeckers indicates that the genetic factors influenc-

ing carotenoid pigments are different from those influencing the melanins, for a number of examples are known in which melanin is lacking and carotenoids are unaffected. A mounted specimen of *Dendrocopos nuttallii* in the Los Angeles County Museum (LACM no. 4821) is pure white except for a normal red crown patch. Deane (1880), in his list of abnormally colored birds, mentions a Golden-winged Woodpecker (= *Colaptes auratus*) which is white except for normally colored areas of yellow and red. Two specimens of the Red-shafted Flicker (*Colaptes cafer*) in the Donald R. Dickey Collection have the usual pattern of melanin coloration, but in one it is extremely pale (UCLA no. D-517) and in the other it is exceptionally dark (UCLA no. A-101). Neither shows any paling or darkening of the red of the remiges and rectrices. A specimen of *Balanosphyra* (*Melanerpes*) *formicivora* in the Museum of Vertebrate Zoology at Berkeley is pale brown in the areas of melanin pigmentation which are normally black in this species; yellow and red are unaffected. A specimen of *S. v. nuchalis* in the Dickey Collection (UCLA no. 50091) has a red-tipped white feather in its crown, an area in which the subterminal parts of the feathers are normally black.

This phenomenon is not restricted to the Picidae. Deane (1876) also refers to an Eastern Kingbird (*Tyrannus tyrannus*) which is yellowish white except for its orange-red crown patch, to a Redpoll (*Acanthis linaria*) which is white except for its red "poll," and to a White-throated Sparrow (*Zonotrichia albicollis*) with its head white except for its yellow superciliary mark. Robinson (1888) records a Cedar Waxwing (*Bombycilla cedrorum*) which is "an almost perfect albino; feet and bill pale yellow; irides pink; a few dark feathers in the wings, rest of plumage pure white except that the yellow tips of the tail feathers and the yellow of the belly and the scarlet wax drops of the wings remained unchanged."

Such evidence indicates that melanin pigmentation may be intensified, diluted, or lacking completely while carotenoid pigmentation remains normal. This strongly suggests, as does the chemical difference between the two kinds of pigments, that the melanins and carotenoids are controlled by different genetic factors. The fact that both pigments are sometimes lacking or diluted together need not affect this conclusion.

Summary of racial characters of pigmentation.—*S. v. varius* is generally the least heavily pigmented, both in carotenoid and melanin, shows the most sexual dimorphism, and is highly migratory.

S. v. nuchalis is more heavily pigmented, shows less sexual dimorphism, and is less migratory.

S. v. daggetti is still more heavily pigmented, especially in carotenoid; sexual dimorphism is slight or absent; migration is much less extensive.

S. v. ruber is larger and most heavily pigmented; there is no sexual dimorphism in color, and migration is slight or absent.

There is good evidence that color differences between the sexes and the races are not under endocrine control.

LIFE HISTORY

A general picture of the life history of the species is provided here in order that similarities and differences among the races may be pointed out, particularly in relation to courtship and reproduction. I have not observed *S. v. varius* except on its wintering grounds, but numerous authors have written incompletely on its breeding activities, and Bent (1939) quotes a number of these sources. The published data on this subspecies do not seem to differ materially from the following account, which is drawn from my field notes on *S. v. nuchalis*, *S. v. daggetti*, and *S. v. ruber* as observed at localities in California and British Columbia.

Sapsuckers of both sexes are present on their nesting grounds early in the spring; in many areas this is before heavy snowfall has ceased. The males of the migratory races seem to arrive a few days before the females. The presence of the birds is made known by frequent drumming or tattooing of a characteristic rhythm, distinct from that of other woodpeckers. This tattooing is difficult to describe adequately, although a single hearing is enough to enable one to recognize it at once thereafter. The tattoo is of about three to five seconds' duration and starts with a steady roll for one or two seconds which is followed by a series of loud taps at irregular intervals for two to four seconds. The Williamson Sapsucker (*S. thyroideus*) uses the same rhythm but a slightly slower tempo. Any resonant surface on which the sapsucker can perch may be used for tattooing. The trunks and limbs of dead trees, especially at great height, are most often used, and dry stubs of branches broken off close to the trunk are much favored. Tattooing may be heard at any time of the day during the entire breeding season, even after the young have left the nest, but it occurs most frequently from dawn through about the first half of the morning during the pre-nesting period. It continues well into the period of nest-construction and slackens off thereafter. Imitations of the tattoos, even if crude, may get a good response before, during, and immediately after nesting. An imitation tattoo near a recently emptied nest usually brings one or both parents to the nest tree and even to the entrance.

The stimuli for tattooing seem to be varied and frequently not determinable with certainty. The birds appear to indulge in it as a general announcement of territory, as part of courtship, and at times of emotional stress.

Adults have five distinct calls in addition to their tattooing noise. The most common is a nasal scream, somewhat reminiscent of the cry of the Blue Jay (*Cyanocitta cristata*). The scream is given at times of alarm or excitement and on many other occasions when no cause is obvious; it may be repeated up to seventy times without pause. A series of retching squawks is given almost invariably during the breeding season when two birds meet, and only then. Rarely, a sound like a combination of a scream and a squawk is produced. A loud series of cries which I call yelps, remotely similar to the yip-yip-yip call of the flicker or the Pileated Woodpecker (*Coeophloeus pileatus*) but slower, is given far less often and I have not been able to correlate it with any particular stimulus. A fifth sound is a faint rattling cry given only when a bird leaves the nest during construction. This peculiar call is uttered as the bird half flutters, half glides from the site; Saunders (1929) has compared this activity with the attitude of other birds in flight song.

Young birds not over a day old are capable of faint cheeping, and from this time on their cries increase in volume and deepen in pitch. Noise is almost continuous for the entire day, and a nest of young over two weeks old can be heard at least a hundred yards away. During the last week of their stay in the nest, the juveniles frequently make a clapping sound which is presumably produced by opening and closing the beak rapidly and repeatedly. In the last two or three days before leaving, the young give occasional screams similar to those of the adults.

I was unable to be on the breeding grounds of the sapsuckers before the start of nest construction except in the case of *S. v. nuchalis*, but since behavior identical to that exhibited by this race in the pre-nesting phase was observed at slightly later stages in both *S. v. nuchalis* and other subspecies, it seems reasonable to assume that the latter behaved similarly at an earlier stage. The following description is typical, then, of at least one race in the pre-nesting period and of this race and two others when observed after nest construction had just begun.

One bird takes a position on a favorable tree and gives several tattoos. Answering

tattoos from one or two birds may come immediately, or several minutes may elapse with no answer. In the latter case, the birds may be silent for a short period, usually about fifteen or twenty minutes, and then start up again. In the event of a nearby tattoo from a different bird, tattooing by the first one continues. The sapsuckers do not seem to wait for an "answer" to be completed, and their noise-making frequently overlaps or almost coincides. Usually three birds are involved, but often two or four and rarely more. Soon one flies over to another, followed by a third, and all begin squawking. At the same time, they hitch about toward and away from one another, bobbing their foreparts up and down and sideways and erecting the feathers of the crown. One bird then flies, followed by the others, and they weave about through the trees within a radius of approximately 100 yards. They alight, and there is more bobbing and squawking and raising of crown feathers. This may take place several more times. Then they separate, and in a few minutes a bird begins tattooing and the whole pattern starts again.

It is noteworthy that in *S. v. nuchalis,* the sexes of which are usually distinguishable in the field, the female sometimes initiates the tattooing and participates in it at least part of the time. Merriam (1879) mentions tattooing by both sexes of *S. v. varius,* and Bolles (1892) records it in captive juveniles of both sexes of this race. Individuals of *S. v. daggetti* which were seen tattooing and later collected proved to be females. Whether or not the female *S. v. ruber* tattoos is unknown.

Bendire (1888) noted such activities among Red-breasted Sapsuckers around Fort Klamath, Oregon, in the range of *S. v. daggetti,* on April 4, which was probably before nesting had begun. He mentions a flock of "at least twenty" birds.

On one occasion I observed tattooing by examples of *S. v. nuchalis* in which one bird tattooed while a second on a nearby branch drummed a brief "roll" at about the midpoint of each tattoo by the first. The duet continued for several minutes until broken up by the arrival of another sapsucker. Because of distance and weather conditions, the sexes of these birds were not determinable with certainty, but the first appeared to be a male and the second a female.

It is difficult to determine whether this sort of behavior is all territorial or whether courtship is involved and, if so, to just what degree. I have not observed any attempts at copulation until well after nest construction has started, and only once have I seen any blows exchanged between sapsuckers regardless of how aggressively they acted. It is possible that courtship and territorial behavior are so closely interwoven that they are not clearly distinguishable—one may be a modified form of the other. From the literature previously mentioned and from my own observations, it is evident that behavior such as that described above begins before nest construction, continues intermittently all through the breeding cycle, and may even occur among the adults of family groups of post-nesting birds.

Territories are variable in size, ranging from an area around the nest site with a radius of roughly 50 yards to over 150. In general, the size of the territory seems to depend on how heavily the area is wooded. On open slopes, territories average larger; in dense groves, smaller.

Copulations or attempts at copulation were observed in *S. v. ruber,* in a male *S. v. ruber* and a female *S. v. nuchalis,* in *S. v. daggetti,* in intermediates between *S. v. daggetti* and *S. v. nuchalis,* and in *S. v. nuchalis.* Successful or not, all attempts agree in that a certain pattern is almost always followed. The female perches crosswise on a branch, and the male approaches her from one side. He moves lengthwise along the branch, fluttering his slightly drooping wings, squawking, and raising his crown feathers. If the female is receptive, she tilts her head far back, sometimes appearing to rest it

on her interscapular region. The male then mounts for about five seconds or less, hops off to the branch, and flies away or begins some other activity. If the female is not receptive, she may actively resist or simply show no head-tilting or cooperation of any kind. All the attempts observed, a total of ten, were made at a time when nest construction was well under way or, in one case, when there were already eggs in the nest.

Nests are excavated in dead trees or in live ones with decayed interiors. The western subspecies are especially partial to large aspens, doubtless because of the soft core of these trees which makes for easy digging. Selection of a site seems to depend purely on local conditions, however, for often a dead or partially dead conifer may be selected even though aspens or other trees of apparently equal suitability are close by. The height at which the nest is constructed varies considerably, although it is usually 20 feet or higher if in a dead conifer. I have seen several nests in aspens which were only 5 feet or a little less above the ground, and in any large tree the nest may be placed at a height of 70 feet or more.

Several excavations may be begun on one or more trees before a final one is selected. Often a tree which has been used in previous years will be chosen. The task of digging is shared equally by both sexes, and a frequent work interval is about half an hour, although this is by no means the rule. Construction is begun at dawn and continues until dusk; it lasts from six days to two weeks, depending on the hardness of the wood. The work is frequently interrupted by long periods of preening or of complete inactivity. The opening to the nest is exceptionally small, and the birds invariably have to struggle to enter and leave. The cavity, like other woodpecker nests, is hollowed out below the entrance and is sufficiently large to allow the adult to turn around inside. The sapsucker nest is about 10 or 11 inches deep and about 3 to 5 inches wide at the maximum, and the opening is usually slightly less than 1.5 inches in diameter.

Eggs are laid and incubation begun as soon as nest construction is complete. The duties of incubation are shared equally by the sexes, and they relieve each other at irregular intervals varying from less than five minutes to an hour and a half. Squawks are almost always exchanged when one bird replaces another, and the nest is rarely left unoccupied for more than a moment. Both sexes have well developed brood patches.

Incubating birds are amazingly reluctant to leave the nest when disturbed, and I have often been unable to count the eggs in a nest because the parent would not come out even though a mirror was poked in or the tree thumped vigorously and repeatedly.

Three to seven pure white eggs are laid, and they hatch in approximately fourteen days. The young are naked when hatched, bright pink in color, and capable of uttering feeble cries. At about seven days unopened pin-feathers have appeared on the major tracts, but the eyes are not yet open. At ten days they are partly fledged, with eyes half open. At fourteen days they appear fully fledged and their eyes are open, but the birds are still small and growth continues for about another ten days. The young then leave the nest singly, and over a period of at least two days.

From the time the young hatch until they reach the age of about six days, the parent always enters the nest to feed them and usually remains until the other adult arrives with food. Occasionally one bird enters while the other is still inside, but they rarely remain in together for more than a moment or two. During the next ten days, the parent enters the nest to feed the young but usually comes out without waiting for its mate. When the young have reached the age of about sixteen days, the parents no longer enter the nest except to clean it and to roost at night. Both sexes clean the nest at irregular intervals, but the male usually does it much more often. The débris is usually carried to the same place each time to be dropped, most often to a tree within 20 yards of the nest.

In the few instances in which I have been able to determine which bird roosts in the nest, it has always been the male. He does this until all the young have left.

Visits to the nest with food are made about every seven minutes for the first five or six days and more rapidly, about every two minutes, thereafter. Feeding continues at this pace from dawn to dusk. This is no apparent coordination of visits by the parents. They may arrive at the nest alternately, together, or one may make several trips between arrivals of the other.

Food for the young consists principally of insects, especially large ants such as those of the genus *Camponotus,* which can be gathered rapidly for the voracious nestlings. In addition, the birds rely heavily on trees close to the nest which are drilled extensively. One or two trees within 5 to 100 yards of the nest site are worked constantly for a supply of vegetable and insect food for both parents and young.

Juveniles are large by the time they leave the nest and may be within a gram or two of the weight of the parents, although the wing and tail measurements are considerably less. For two or three days before emergence the young indulge in periods of hanging half to two-thirds out of the nest entrance. Then, without any apparent stimulus, the young bird pops out and flies unsteadily away. Sometimes the juvenile gets no farther than the ground a few feet from its point of departure, but usually it goes to a tree close by or up to 75 yards away, depending on the height of the nest site. Parents may show great concern over a juvenile which is just out, especially the first one, or they may give it no apparent attention, at least at first. When attention is shown, the parent seems to try to lead the young one to higher elevations and/or to one of the well worked trees in the vicinity. Feeding of the young still in the nest continues at the same rapid pace during some intervals, but with interruptions of a few minutes to almost an hour. The adults also feed the emerged juveniles, but not regularly, and the latter begin to attend to their own wants almost immediately. Their dull mottled plumage is quite effective as concealing coloration. A family group appears to be maintained for at least three or four days after all the young are out; how much longer the association continues is not known.

Nesting sapsuckers show aggressive behavior principally toward others of their own species (even if the intruder is of a different race) and other woodpeckers of similar size, such as Hairy Woodpeckers (*Dendrocopos villosus*). As a rule non-picids are not attacked even though they may attack the sapsucker. At sap workings behavior is sometimes different, and other birds may be chased or given battle.

INTERBREEDING OF DAGGETTI AND RUBER

The breeding ranges of these two subspecies meet in southwestern Oregon in an area between the Klamath Lake region and the coast. Birds from the interior part of the contact are usually very close to one race or the other (Gabrielson and Jewett, 1940), but along the coast the characters of the two forms blend gradually. Grinnell (1937) assigned all Californian specimens to *daggetti,* but some birds from the northwest coast of California are indistinguishable from examples of *ruber* which have slightly more than the usual amount of white spotting. It is true, however, that no Red-breasted Sapsuckers from California are as dark as the darkest examples of *ruber,* but any line drawn to separate the two races along the coast is an arbitrary one. Interbreeding of coastal populations of these races appears to be extensive, as would be expected in the absence of abrupt habitat differences and in view of the fact that these two races are the most similar to each other of the four.

INTERBREEDING OF DAGGETTI AND NUCHALIS

Intermediates between these two races are fairly common in collections, but the zone of interbreeding is limited and narrow. *S. v. nuchalis,* primarily a bird of the Rocky

Mountain region, extends its range westward to the east slope of the northern Sierra Nevada and that of the entire Cascade range. Thus, in east-central and extreme northeast California and in the Cascade region of southern Oregon, the range of *nuchalis* touches the more limited one of *S. v. daggetti*, which is restricted principally to the Sierra Nevada. Intermediates have been collected during the breeding season in Mono County, California, and especially in parts of Modoc County, California, by parties from the Museum of Vertebrate Zoology.

Adult birds showing characteristics of both these races are classified here into seven phenotypic categories ranging from *daggetti* to *nuchalis*. These may be characterized and numbered as follows:

1. Typical *nuchalis*.
2. Close to *nuchalis*, but with traces of *daggetti* characteristics.
3. Some definite *daggetti* characteristics, but decidedly closer to *nuchalis* than to *daggetti*.
4. Approximately intermediate between *nuchalis* and *daggetti*.
5. Some definite *nuchalis* characteristics, but decidedly closer to *daggetti* than to *nuchalis*.
6. Close to *daggetti*, but with traces of *nuchalis* characteristics.
7. Typical *daggetti*.

As the characters involved do not lend themselves to precise quantitative treatment, the categories are necessarily somewhat arbitrary and subjective. A more specific classification would, however, be spurious. Wear frequently causes pre- and post-nesting birds to appear very different, although they might be almost identical in fresh plumage. I have therefore placed the birds in the categories listed only after examining the specimen, if present, and the description in my field notes. There is, unfortunately, no way of being absolutely certain that some of the birds classed as type 2 or type 6 are not extreme variants of one or the other race, but as they were observed in a zone of intergradation between two forms the number of such errors is probably small.

No satisfactory way of classifying juvenal intermediates into more than three categories has been found. Darker and sootier color of the head region and the lack of a white postocular stripe are characters of *daggetti*, and lighter, less sooty head coloration and the presence of more than a small spot of white in the postocular region are *nuchalis* characters. Sometimes these characters are clearly visible in the field, as when a juvenile thrusts its head out of the nest entrance and cries for food. It was thus possible in some instances to record that the young of a certain pair were of "*daggetti*-type" or "*nuchalis*-type" or both, even though they were not collected. The distinctness of such characters depends to some extent, however, on the age of the young bird, and as my specimens are in many cases of different ages it seems unwise to try to fit intermediate juveniles into a system such as that used for classifying the adults. Therefore, juveniles with plumage characters close to those typical of one race are referred to as *daggetti*-type or *nuchalis*-type, and those not especially close to one or the other race are referred to as intermediate in plumage characters. When young from the same nest show intermediate characters but are not identical, they are referred to as variously intermediate.

Of eleven breeding sapsuckers from 9 miles west of Benton, elevation 8300 feet, Mono County, California, ten are typical *daggetti* and one is type 3 *daggetti* (MVZ no. 84843). A bird taken at a point 7 miles west and 2 miles south of Benton, elevation 9000 feet, is typical *daggetti* (MVZ no. 84852). Seven birds taken on Mount Patterson at elevations of 7900 to 8200 feet in the Sweetwater Mountains in Mono County are typical *daggetti*; a single typical *nuchalis* was taken at this same locality at an elevation

of 9000 feet. These areas in Mono County are largely within the main range of *daggetti*, and interbreeding with *nuchalis* is apparently extremely slight.

In Modoc County, *S. v. nuchalis* is the predominant form in the Warner Mountains in the extreme eastern part of the county. Of fifty-four breeding birds and well developed juveniles from the Warner Mountains, fifty-one are typical *nuchalis*. One adult from Pine Creek, elevation 8500 feet, is typical *daggetti*; one adult from Sugar Hill is *daggetti* or possibly type 6; one adult from the east face of Warren Peak is type 4.

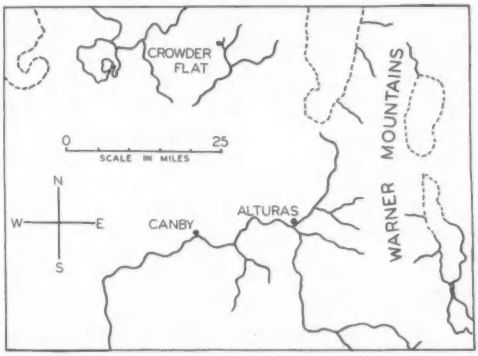

Fig. 3. Map of Modoc County, California, showing localities mentioned in text. Broken lines indicate borders of intermittent lakes.

From the area about 40 miles west of the Warner Mountains at a point 8 miles west of Canby, Modoc County, three specimens are typical *daggetti* and one is type 4. The latter, a female (MVZ no. 115754) was presumably mated to one of the *daggetti* males (MVZ no. 115775), for the two were collected at the same nest excavation, but one day apart. Several other typical *daggetti* were seen in this region, but no *nuchalis*.

At Crowder Flat about 20 miles west of the Warner Mountains and 38 miles northwest of Alturas, Modoc County, *daggetti* is also the predominant form. The elevation at Crowder Flat is about 5200 feet, and the yellow or ponderosa pine is the most conspicuous tree. Associated with it are mountain mahogany (*Cercocarpus*), manzanita (*Arctostaphylos*), *Ceanothus prostratus*, and, bordering the numerous creek meadows, aspen. To the east, the elevation decreases and a broad stretch of about twenty miles of juniper (*Juniperus occidentalis*) and sagebrush (*Artemisia*) separates the area from the Warner Mountains. The expanse of juniper and sagebrush forms something of a barrier for sapsuckers, as they do not breed in this association, but it is hardly insurmountable as the birds might readily cross it.

In 1948 sixteen specimens of *S. varius* were secured at Crowder Flat. In the spring of 1949 I returned there and stayed for forty-five days. Twelve successful sapsuckers nests were found and studied, and twenty-four specimens were collected. The characteristics of adult sapsuckers collected or closely observed during these two years are summarized in the following table.

Table 1

Phenotypes of Adult Sapsuckers Collected or Closely Observed at Crowder Flat in 1948 and 1949

Type	1	2	3	4	5	6	7
No. of individuals	8	1?	1	1	7	10	14

Thus, of forty-two individuals, twenty-two are typical of one race or the other (types 1 and 7) and twenty show intermediate characteristics. The fact that only about half of the birds can be safely assumed to be of mixed racial stock indicates that interbreeding is moderate but not free.

In the following section a brief history of each of the nestings studied at Crowder Flat is given, illustrating the varied phenotypes of the breeding stock, the participation of the parents in nest activity and the reproductive success. The nests are listed in the sequence in which they were discovered. (See fig. 4 for location of nests.) Observations were usually made for a two-hour period at as many different times of day as possible.

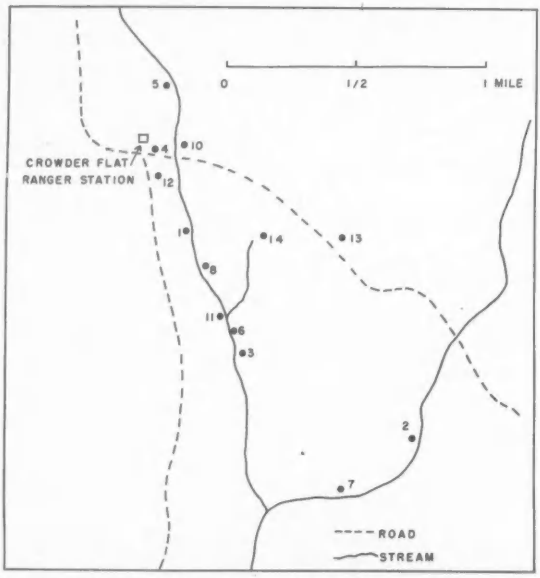

Fig. 4. Vicinity of Crowder Flat, Modoc County, California, showing locations of Yellow-bellied Sapsucker nests in 1949.

Counts of eggs and observations of young were made by inserting a dentist's mirror into the nest and reflecting a flashlight beam down to the bottom. Except for these intrusions, special care was taken to disturb the birds as little as possible; such precautions necessarily involved inexactness in counting the young, especially at the more active ages.

In those cases in which nests were within 150 yards of each other, it was possible to estimate territorial size; when the distance between nests was greater, the birds had so few occasions for territorial defense that no accurate estimation of the size of the territory was possible. In general, it appeared that the sapsuckers would defend an area around their nests within a radius of about 50 or 75 yards. The cruising range of the birds was much greater, extending at least 200 or 300 yards from the nest provided that the territory of another was not penetrated.

Nest 1

This nest was observed for approximately forty-two hours over a period of thirty-nine days, from May 21 to June 29. It was situated about five feet above ground in a dead aspen which contained many other woodpecker holes.

Parents.—Male, type 6; female, type 3 (MVZ no. 117131). Sometime after June 21, the male disappeared; he was not seen again after that date.

Territory.—The size of the territory was not determined, but the nest closest to this one was no. 8, 350 yards away.

Eggs and young.—At least three eggs were seen on May 24, and five were counted on May 26. They were hatched by June 5. At least four young were raised and a fifth one may have been present; an exact count was not possible without destroying the nest before their emergence. The first two to emerge were of *daggetti*-type plumage; two others which were collected (MVZ nos. 117132-117133) show intermediate characters. The young were in the nest for a minimum of twenty-three days, and they left on June 28 and 29.

Incubation and feeding.—Both parents participated. A mountain mahogany about forty or fifty yards from the nest was commonly used as a food source. Visits as usual were not coordinated. On one occasion the birds collided in mid-air in front of the nest as they approached from opposite directions.

Roosting.—On May 30 the male roosted in the nest. On June 21 and June 26 the nest was watched until dark, and the female did not roost in it. The male was no longer present.

Nest sanitation.—The male was seen to clean the nest twenty-nine times; the female was never observed in this activity.

Remarks.—On two occasions a *nuchalis,* a different one each time, alighted on the nest tree, but the parent birds were not present and the visitor flew off undisturbed. The only bird which elicited an aggressive response was a Hairy Woodpecker which came to within 10 yards of the nest. The female chased it as she came out of the nest from feeding the young, and the male did exactly the same thing about a minute later. The chases, however, were somewhat lethargic, for no sounds were uttered, no physical contact made, and the Hairy Woodpecker showed no resistance.

The nesting was successful despite the fact that the male parent disappeared at the time that most intensive feeding was in progress. The female and two of the young were collected.

Nest 2

This nest was observed for a total of approximately two hours over a period of twenty days, from May 21 to June 2, and from June 25 to July 2. The nest was in a live aspen at a height of about four feet. In the same aspen were several other woodpecker holes.

Parents.—Male, type 6 (MVZ no. 117148); female, type 4 (MVZ no. 117147).

Territory.—The size of the territory was not determined, but the nest closest to this one was no. 7, over 500 yards away.

Eggs and young.—Five eggs were seen on May 26; when next examined, on June 2, the nest was empty. A second laying was probably begun about June 7. The second nesting was in the same hole as the first. Cries of young were heard on June 25, and there were four in the nest on July 2, when they were collected. Their age was approximately ten days (T.R.H. field nos. 398-401). Plumage is intermediate in character.

Incubation and feeding.—Both parents participated.

Remarks.—On May 21 two attempts at copulation were made by this pair in the manner described in the section on life history. This was on the day that I found the nest, and I did not look in it then. However, as the male went into the nest and apparently incubated immediately after the mating attempts and as three eggs were seen in the nest the next day, May 22, it is evident that the copulations were attempted after eggs had already been laid.

Nest 3

This nest was observed for approximately thirty-two hours over a period of forty-two days, from May 22 to July 3. It was situated about 8 feet up in a live aspen which contained other woodpecker holes.

Parents.—Male, *daggetti* (MVZ no. 117145); female, *daggetti* (MVZ no. 117146).

Territory.—The nest closest to this one was no. 6, 100 yards away. A territory around the nest with a radius of about 50 yards was maintained.

Eggs and young.—The eggs were not seen until the time of hatching, on June 3. An attempt to see them was made earlier but the parent would not leave the nest. On June 3, the parent remained

in the nest but shifted enough so that a newly-hatched young bird and half an eggshell could be seen. At least three young were raised, all *daggetti*. All left the nest on June 28 and 29; thus, the maximum period in the nest was twenty-six days, from June 3 to 29.

Incubation and feeding.—Both parents participated in incubating and feeding. Two clumps of mountain mahogany, each about 60 yards from the nest, and an aspen about 5 yards from the nest tree were used as food sources.

Roosting.—By June 26 it was possible to distinguish between the parents through a difference in plumage abrasion. Roosting had been noted on June 20 and 25, but it was not possible to tell which bird was involved. On June 28, the day before the last of the young emerged, the now-distinguishable male roosted in the nest.

Nest sanitation.—The nest was cleaned frequently, but it was not possible to tell whether one or both parents did the cleaning.

Remarks.—One of the sapsuckers chased a *daggetti* that had come close to the nest from some other territory, and on another occasion an intermediate-plumaged sapsucker was chased by a bird from nest no. 3. Chipmunks were chased twice. Flickers, Hairy Woodpeckers, and various passerine birds were ignored. On May 22, while I was marking the nest tree, one of the adults flew to a dead branch of a tree about 5 yards away and tattooed loudly. On June 27 the female was heard tattooing; no stimulus was apparent. On July 1, after all her young were out, she tattooed in the course of chasing another sapsucker from near her empty nest.

Nest 4

This number was given to a site by which much sapsucker activity was noted on May 23, but which was not used for nesting. In all probability the birds observed were those which later nested at no. 10 and no. 12. Forty minutes of courtship and/or territorial behavior among three birds, all type 6, was witnessed at "nest" no. 4 on May 23, and a typical copulation attempt was observed in the course of this activity. At one point two birds scuffled bill to bill in the air about 4 feet above the ground and then fell into the grass below. For the most part, their behavior involved tattooing, chasing each other, and squawking when they alighted.

Nest 5

This nest was observed for approximately eleven hours over a period of eight days, from May 23 to May 30, and again on June 26. The birds abandoned the excavation at some time between May 26 and 30, and a visit on June 26 showed that the site had not been put to any further use. The excavation was about 7 feet from the ground in a live aspen which contained several other woodpecker holes.

Parents.—The sexes could not be distinguished. One bird was typical *daggetti* and the other type 6.

Territory.—The size of the territory was not determined, but the nest closest to this one was no. 10, about 400 yards away.

Construction.—Both birds participated in the construction work.

Remarks.—This pair was first seen at a slight excavation 2½ feet above ground in a live aspen about 10 yards from the site on which the most work was done. The latter had already been started before the other was attempted. The reasons for abandoning either or both were not apparent; possibly the proximity of a Douglas squirrel nest was a factor. A Hairy Woodpecker was chased by a sapsucker from close to the nest site to 20 yards away, after which the birds were lost to sight. Pursuit was silent and not very aggressive.

Nest 6

This nest was observed for approximately eighteen hours over a period of forty days, from May 24 to July 3. The nest was between 4 and 5 feet above ground in a live aspen which contained several other woodpecker holes.

Parents.—Male, type 6 (MVZ no. 117150); female, type 5 (MVZ no. 117149).

Territory.—This site was between nests no. 3 and no. 11 and 100 yards from each; a territory around the nest with a radius of about 50 yards was maintained.

Eggs and young.—Five eggs were seen on May 25, and all were hatched by June 5. There were at least four young later, and their head patterns showed that two were of *daggetti*-type and two were intermediate. It was impossible to make an exact count without destroying the nest and it is

entirely possible that a fifth young bird was present. They left the nest over a period of three days, July 1 to 3, which indicates a minimum time in the nest of twenty-six days and a maximum of twenty-eight.

Incubation and feeding.—A minimum incubation period of eleven days is indicated. Both parents participated in incubation. An aspen 10 yards from the nest tree was used extensively as a food source.

Roosting.—Although the parents could be told apart, the nest site was too dark at dusk to tell which bird roosted in the nest. One of the parents did so on the evening of July 1, after at least one of the young had left.

Nest sanitation.—Only the male was seen to clean the nest; this was observed six times.

Remarks.—A pair of House Wrens had a nest in an old sapsucker hole about 1 foot below nest no. 6. The sapsuckers were frequently flown at or struck by one of the wrens as the former came to feed their young; once the male sapsucker was driven to the ground by his smaller assailant. Usually the sapsuckers attempted to dodge the wren, and they never struck back at it.

On June 30, a juvenal sapsucker (probably from no. 3) flew over to the aspen used for feeding by the adults from no. 6 while they were there and begged from them. Both the adults, especially the female, attacked the juvenile viciously although it continued to approach them and beg. On that date the young of no. 6 were not out of the nest yet, and this fact may have enabled the parents to know that the young one was not their own. The juvenile obviously reacted to these adults as it would to its own parents, even after it was attacked.

Nest 7

This unusual nest, involving one male and two females, was observed for approximately forty-two hours over a period of thirty-eight days, from May 26 to July 2. The nest was between 10 and 11 feet above ground in a live aspen with many other woodpecker holes in it.

Parents.—Male, *daggetti* (MVZ no. 117144); female, *nuchalis* (MVZ no. 117143); female, type 5 (MVZ no. 117142).

Territory.—The size of the territory was not determined, but the nest was about 500 yards from no. 2 and about 880 yards from no. 3.

Eggs and young.—On June 8, six eggs and two newly hatched young were seen. Exchange of places in the nest was noted on May 24, and eggs were probably present at that time. Five young were raised to an approximate age of twenty-four days, at which time they were collected (MVZ nos. 117137-117141). All proved to be males, and the plumage types include one *daggetti*-type, one *nuchalis*-type, and three intermediates. The fate of the other three eggs is not known.

Incubation and feeding.—All three birds participated in incubation. The two females were in together frequently but usually only momentarily; occasionally they were in joint occupation for over nine minutes. The male often went in when either one of the females was inside, but the female generally emerged as soon as the male entered. No favorite feeding tree was discovered in this case, but the small willows (*Salix*) along a creek about 40 yards away were often visited.

Roosting.—On two occasions it was determined with certainty that the male roosted in the nest. At one of these times it is possible that the intermediate female also roosted in the nest, but this is uncertain.

Nest sanitation.—All three birds cleaned the nest frequently, but the male did this most often.

Remarks.—On May 26, the male appeared to fly at a White-headed Woodpecker (*Dendrocopos albolarvatus*) which came to within 10 yards of the sapsucker nest. On June 8, a Hairy Woodpecker tapping on the nest tree was ignored. On the latter date the intermediate female chased a House Wren from near the nest. On June 10, a possible type 2 came to the nest tree, hitched about, and squawked a little. The intermediate female was in the nest at the time. She looked out, saw the stranger, and then came out of the nest and chased the bird away with great vigor.

Occasionally two of the three birds, male and female or the two females, chased one another and squawked at each other with their crown feathers raised, but there seemed to be no real conflicts.

This nest was at least partly successful in that five young were raised under very unusual circumstances. The adults and young behaved exactly as those involved in a normal nesting. Considering this fact, it seems likely that the offspring were derived from both females, although it is impossible to determine which young had which mother.

Nest 8

This nest was observed for approximately three hours over a period of thirty-five days, from May 26 to June 29. It was situated about 7 feet above the ground in a live aspen which contained a few other woodpecker holes.

Parents.—Male, *daggetti* (MVZ no. 117136); female, type 6 (MVZ no. 117135).

Territory.—The size of the territory was not determined, but the nest was about 350 yards from no. 1 and about 400 yards from no. 11.

Eggs and young.—There were at least three eggs, for on June 5 one newly hatched young and two hatching eggs were seen. My presence at this moment put the parents in such an agitated state that I did not take time to make sure that there were no more eggs or young. The three young all seemed to be of the *daggetti*-type plumage. They left the nest by June 29, twenty-four days after hatching.

Incubation and feeding.—Only one bird, the male, was seen to incubate, but only two hours and twenty minutes were spent observing before the young hatched. This did not provide sufficient evidence to suggest that one bird did all the incubating. Both parents participated in feeding the young.

Nest 9

This nest was found at Howard's Gulch, 2½ miles west of Canby, Modoc County, California. It was observed only on June 4, for less than one hour. It was situated about 7 feet from the ground in a live aspen.

Parents.—A *daggetti* was seen at this nest several times; it was not possible to tell whether this was the same bird each time.

Young.—There were at least three naked, recently-hatched young.

Nest 10

This nest was observed for about five hours over a period of nine days, from June 20 to 28. It was situated about 50 feet from the ground in a dying ponderosa pine which contained numerous other woodpecker holes.

Parents.—The sexes could not be distinguished; both were type 6.

Territory.—This nest was about 150 yards from no. 12; the territory of no. 10 extended about 75 or 100 yards in that direction.

Eggs and young.—The nest was not discovered until after the eggs were hatched. The inaccessibility of the nest prevented an accurate count of young.

Feeding.—Both parents participated.

Nest sanitation.—Both parents were observed to clean the nest.

Remarks.—On June 21 a *daggetti* alighted at the top of the nest tree and began to tap, not tattoo, on a branch. The brooding adult came out of the nest, and another, presumably its mate, flew up to the nest tree. A confused chase followed, and one sapsucker, probably the intruder, was driven off. A moment later one adult came to the nest with a large-winged insect and went in; a minute later, the other member of the pair came to the nest and places were exchanged. Thirteen minutes later two Mountain Chickadees (*Parus gambeli*) came close to the nest entrance; the brooding adult looked at them but did not come out. Earlier a White-breasted Nuthatch (*Sitta carolinensis*) had scrambled around noisily about 18 inches from the nest and the brooding adult had come to the entrance and looked at it. It appeared that the sapsuckers investigated any tapping or scratching noise on the nest tree and became aggressive if the noise-maker was another sapsucker.

This nest was on a later schedule than the others at Crowder Flat. The young had emerged from all the other sapsucker nests under observation except no. 2 by July 3; by this date the young in nest no. 10, to judge by their cries and the behavior of the parents, were about sixteen days old. The adults described under "nest" no. 4 were probably from this nest and nest no. 12.

Nest 11

This nest was observed for approximately one and three-quarter hours over a period of twelve days, from June 22 to July 3. The nest was about 11 feet from the ground in a live aspen which contained several other woodpecker holes.

Parents.—The sexes could not be distinguished; one bird was *daggetti,* and one was type 6.

Territory.—This nest was 100 yards from no. 6 and 400 yards from no. 8. A territory extending about 50 yards in the direction of no. 6 was maintained.

Eggs and young.—The nest was not discovered until after the eggs were hatched and an accurate count of young was not possible. Only the *daggetti*-type plumage was noted among them. They had left the nest by July 2.

Feeding.—Both parents participated in feeding the young.

Nest 12

This nest was observed for approximately three hours over a period of ten days, from June 22 to July 1. It was situated about 45 feet up in a dead ponderosa pine which was broken off at the top 2 feet above the nest. There were several other woodpecker holes in the same tree.

Parents.—The sexes could not be distinguished; one bird was type 6, the other type 5.

Territory.—This nest was about 150 yards from no. 10; the territory of no. 12 extended about 75 yards in that direction.

Eggs and young.—The nest was not discovered until after the eggs were hatched. At least three young were out of the nest on July 1, and they appeared to be of the *daggetti*-type or possibly intermediate.

Feeding.—Both adults participated.

Nest sanitation.—Only the type 6 bird was seen to clean the nest; this was observed five times.

Remarks.—The adults described under "nest" no. 4 were probably from this nest and nest no. 10.

Nest 13

This nest was not discovered until June 23; it was observed for approximately one hour over a period of three days, from June 23 to June 25. The nest was about 50 feet above the ground in a dead ponderosa pine which contained numerous other woodpecker holes.

Parents.—The sexes could not be distinguished; both adults were type 5.

Territory.—The size of the territory was not determined, but the nest closest to this one was no. 14, 600 or 700 yards away.

Young.—An accurate count was not possible.

Feeding.—Both parents participated in feeding the young.

Remarks.—The nest was empty and the adults were absent from June 25 on. Presumably the young left the nest between June 23 and 25, as they appeared to be over twenty days old when discovered on June 23.

Nest 14

This nest was not found until June 29; it was observed for approximately one hour over a period of four days, from June 29 to July 2. The hole was about 50 feet above ground in the dead top of an otherwise live ponderosa pine.

Parents.—The sexes could not be distinguished; one adult was a *daggetti,* and the other type 5.

Territory.—The size of the territory was not determined, but the nest closest to this one was no. 13, 600 or 700 yards away.

Young.—An accurate count was not possible. Those that were seen looking out of the nest entrance were of the *daggetti*-type.

Feeding.—Both parents participated in feeding the young. A mountain mahogany about 100 yards from the nest was extensively used as a food source.

Nest sanitation.—Only the *daggetti* parent was seen to clean the nest; this was observed four times.

Remarks.—All the young had left the nest by the afternoon of July 2; one was seen in the nest on the morning of that day.

SUMMARY OF DATA ON NESTINGS IN MODOC COUNTY

Locations.—Ten nests were in aspens and three in ponderosa pines.

Parents.—The adults included typical *daggetti,* typical *nuchalis,* and all stages of intermediate plumage.

Territories.—The minimum distance between nests was 100 yards, and the minimum territory seemed to be an area around the nest with a radius of about 50 yards. Maximum territories were not determined.

Nest building.—This was observed in only one pair (no. 5); both adults participated equally.

Eggs.—A minimum of three and a maximum of five eggs were noted among the pairs. Nest 7, with three adults, had eight eggs but only five young were raised.

Incubation.—Both sexes participated equally in incubation.

Young.—The plumage of the young ranged from typical *daggetti* through all stages of intermediacy to typical *nuchalis*. Twenty-three to twenty-eight days elapsed between hatching and leaving the nest.

Feeding.—Both sexes participated equally in feeding. Mountain mahogany and aspen were used extensively as food-gathering places, and large ants and insects caught on the wing formed a large part of the diet of the young.

Roosting.—Only males were seen to roost in the nest, although it is possible that females did also. In at least one instance an adult roosted in the nest after one or more of the young had left.

Nest sanitation.—Both sexes were seen to clean the nest, but males did this much more often than females.

Behavior toward other animals.—Occasionally chipmunks and Hairy Woodpeckers were chased. Once a White-headed Woodpecker was chased and once a House Wren. A sapsucker which ventured near the nest of another was always chased if seen. No other birds or small mammals elicited an aggressive response even if they attacked the sapsuckers, as one House Wren did.

Reproductive success.—There was no evidence of any lack of viability or fertility among the birds showing intermediate racial characters. An unusual nest involving three birds, two of different races and one an intermediate, was at least partly successful. Other nests involving intermediates, such as no. 1 and no. 2, were successful despite adverse conditions. Birds of mixed and unmixed racial stock seemed to be equal as regards reproductive success. However, since only twenty-one out of forty-six adult birds collected or observed at Crowder Flat during two breeding seasons showed intermediate characteristics, interbreeding between the races is apparently moderate but not free.

INTERBREEDING OF VARIUS AND NUCHALIS

The breeding ranges of *S. v. varius* and *S. v. nuchalis* presumably meet along the eastern edge of the Rocky Mountains in western Alberta, an area which has not been extensively collected, and the amount of interbreeding which takes place is thus difficult to determine. The status of the two races in this region is still obscure (Rand, 1948), and I have not been able to locate a specimen of a breeding intermediate. Mr. W. Earl Godfrey informs me (*in litt.*) that in the National Museum of Canada there is only one example of *nuchalis* from Alberta, and that there are "specimens of *varius* from localities east of the Rockies which show more or less red coloration on the nape. Such males are from Edmonton and Wood Buffalo Park, Alberta; Flotten Lake, Saskatchewan; Lake Winnepegosis, Manitoba; Kapuskasing, Ontario; and Megantic County, Quebec. The last, incidentally, has the nape more extensively red than any of the other specimens of *varius* listed above. These birds, as would be expected, show not the slightest tendency toward *nuchalis* in any other character."

Variation in one race never produces an individual indistinguishable from examples of the other race, but such variation may overlap the characteristics of birds intermediate between the two. This fact makes it impossible to identify positively some birds which may be either intermediates or extreme variants of one or the other subspecies. Some specimens must remain indeterminate because the collector lost many of the nape

feathers in skinning out the head through a slit in the back of the neck—a common practice in preparing woodpecker skins. Females can be classified in this regard with some assurance if they are blacker than typical *varius* and have either a white nape and red spotting on the throat or a red nape with a white or almost completely white throat. There is a greater possibility of error in identifying males as intermediates because the entire throat is red in this sex in both races, but the color of the nape and the amount of black generally gives some indication of mixed or unmixed heritage.

Mr. H. G. Deignan kindly examined the series of hundreds of sapsuckers in the United States National Museum and selected only five as possible intermediates. These are a male (USNM no. 27140) from Fort Rae, Mackenzie, no date, with considerable red on the nape; a female (USNM no. 140600) from Flathead Lake, Montana, July 12, 1895, which is like *nuchalis* but with no red on the nape; a similar, unsexed bird which is clearly a female (USNM no. 10779) from Fort Bridger, Wyoming, May 18, 1858; a female (USNM no. 10184) from Wind River, Nebraska, May 27 (!), 1860, which resembles *nuchalis* except for a white nape; and a female (USNM no. 112922) from San Antonio, Texas, February 22, 1887, which is like *varius* but with the throat heavily spotted with red. Of these five, I regard the Montana bird as the most questionable as some of the nape feathers are missing, the Texas and Nebraska birds as intermediates, and the other two as possibly so.

I have also examined a series of fifty-one sapsuckers from México in the Robert T. Moore Collection and found one which seems definitely an intermediate. This bird (RTM no. 27012) is a female resembling *varius* but with red spotting on both nape and throat; it was collected one mile north of Tapalpa, Jalisco, México, on April 2, 1940.

It is readily apparent that the amount of interbreeding between these two races is indeterminate at present, but in view of the scarcity of even likely intermediates it is probably not extensive. It also seems probable that the contacts between the two races during the breeding season are somewhat limited.

INTERBREEDING OF VARIUS AND RUBER

Contacts between the ranges of *S. v. varius* and *ruber* are known only in northern British Columbia, and there are only two published records of the meeting of *varius* and *ruber* on the nesting grounds. Swarth (1922) reported three sapsuckers observed about 5 miles from Telegraph Creek, British Columbia, two of which were collected. One (MVZ no. 39780) is a typical male *S. v. varius*; the mate of this bird was seen and described as having "a great deal of red about the head, almost obliterating the black pectoral patch." These two had a nest "twenty-five feet from the ground, in a dead birch in rather open woods." On June 19, the next day, another male sapsucker was taken about half a mile away; this bird (MVZ no. 39781) has red tips to the feathers of the black auricular patch, the black malar stripe, the white subauricular stripe, the nape, and the black pectoral patch, the posterior border of which is still sharply defined. As Swarth noted, this specimen bears a curious resemblance to a *nuchalis* with tendencies toward *ruber* or *daggetti*. There can be no doubt, however, that it is an intermediate between *S. v. varius* and *S. v. ruber* as Telegraph Creek is hundreds of miles outside the ranges of *nuchalis* and *daggetti* and typical *ruber* was found at Doch-da-on Creek, 50 miles to the southwest.

Cowan (1939) found a pair of typical *ruber* excavating a nest in an aspen on May 23 at Tupper Creek, British Columbia, in the Peace River parklands. This author also noted that 8 feet away (unusually close) a pair of *S. v. varius* was nesting, and that another pair of *varius* had a nest within a radius of 50 yards of the other two. There

were no other *ruber* discovered in this region, which is within the normal range of the race *varius*.

There are no other accounts of the meeting of these two races on their breeding grounds, and the two intermediates recorded by Swarth are the only ones known. Probably the relationship between *ruber* and *varius* is very similar to that between *ruber* and *nuchalis*, as in the latter case there is also an extreme scarcity of intermediates as well as side by side nesting of pairs of each subspecies. Further data are needed from presently inaccessible regions in northern British Columbia.

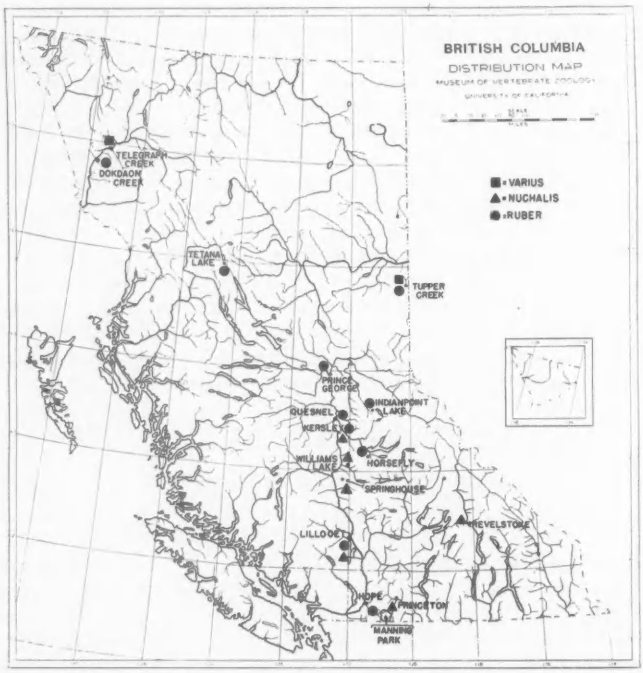

Fig. 5. Breeding localities at or near the peripheries of the ranges of the three subspecies of Yellow-bellied Sapsucker in British Columbia. There are summer records but not definite breeding records of the forms shown at Lillooet.

INTERBREEDING OF NUCHALIS AND RUBER

Washington and Oregon.—The breeding ranges of these races come in contact along the Cascade Mountains from southern Oregon north across the international boundary and from there north through the Cariboo region in central interior British Columbia. In general, *nuchalis* occurs east of the contact and *ruber* to the west, but at the northern limit the range of *ruber* extends east to the western slope of the Rocky Mountains; along this boundary *ruber* is found to the north and *nuchalis* to the south.

The Cascade Range seems to provide an effective barrier between the races, for only two intermediates have been recorded from Oregon, only two from Washington, and

none from southern British Columbia. The birds from Washington showing intermediate characters were collected at Cabin Creek, 33 miles west of Yakima, Yakima County, by Mr. John B. Hurley. He collected six birds at this locality from May 16 to May 23, 1948. Four of these (MVZ nos. 116134-116137) are typical *ruber*, but two show definite intermediate characteristics. Using the same system of categories as that employed for specimens of *daggetti* and *nuchalis* but substituting *ruber* for *daggetti*, MVZ no. 117606, taken May 16, 1948, is type 2; MVZ no. 117607, taken May 23, 1948, is type 6. The locality at which they were taken is on the east slope of the Cascade Range.

In June of 1948 a party from the Museum of Vertebrate Zoology collected sapsuckers on both slopes of the Cascade Range in central Oregon. Descriptions of the flora in the area are drawn from the field notes of Dr. Alden H. Miller. On the west slope of the mountains at North Santiam River, elevation 3400 feet, Linn County, the forest growth is "fir, hemlock, alders, willows;" here five typical *ruber* were collected. On the east slope, at a point 4 miles north and 9 miles west of Sisters, elevation 4000 feet, Deschutes County, there are "clumps of aspen, park-like yellow pines, groups of firs and occasional lodgepole pines;" here two typical *ruber* were collected, and one type 5 (MVZ no. 83412). Four miles away, at a point 7 miles northwest of Sisters, elevation 3300 feet, the vegetation is similar—"aspen and mixed forest;" here six typical *nuchalis* were collected and one type 2 (MVZ no. 83393). It appears that in this region there are definite ecologic differences between the races, for although *ruber* seems to have pushed out of its usual habitat successfully for a short distance it is replaced within a few miles by *nuchalis* in the aspen-conifer mixed forest. Interbreeding is apparently very limited as only two intermediates were found.

Manning Park area.—In 1950 I spent the period from May 9 to June 6 in E. C. Manning Provincial Park, between Hope and Princeton, British Columbia. This area, in the northern Cascade Mountains, has recently been made accessible by an excellent highway connecting the two towns, but snow conditions prevented any field work except that within a mile of the road in the critical localities.

Approximately 50 miles by speedometer southwest of Princeton, the road crosses Allison Pass at an elevation of 4400 feet. The humid coast climate and the coast forest appear to reach their easternmost limit in the park at this pass; to the east, the elevation declines and the climate becomes progressively drier. In the terminology of Munro and Cowan (1947), the region west of Allison Pass is in the coast forest biotic area, and that to the east is in the subalpine forest biotic area. A useful indicator of these areas in Manning Park is the western red cedar (*Thuja plicata*), which occurs in the coast forest west of the pass but which is absent to the east of it. Trees found on both sides of the pass but not necessarily throughout both biotic areas include western hemlock (*Tsuga heterophylla*), Douglas fir (*Pseudotsuga taxifolia*), alpine fir (*Abies lasiocarpa*), Englemann spruce (*Picea Engelmanni*), lodgepole pine (*Pinus contorta*), black cottonwood (*Populus trichocarpa*), and aspen.

Unfortunately, a forest fire in July of 1945 destroyed almost all the timber over hundreds of acres in an area on either side of the road from about 2 miles west to 5 miles west of the pass. The burn is ellipsoidal and its greatest dimensions are approximately 2.7 miles by 1.2 miles. The Hope-Princeton highway runs through the burn parallel to its long axis and almost bisects it. This gap of 2.7 miles seemed to constitute a barrier for sapsuckers, as typical *S. v. nuchalis* was found nesting up to its eastern edge and typical *S. v. ruber* was found nesting up to the western edge. As the fire occurred in July it is probable that any nests of mixed pairs or intermediates which may possibly have existed were destroyed, for sapsuckers nesting on either side of the burn still had young

in the nest on July 13, 1950. In any event, the status of the races in this area at the present time is as follows.

Ruber occurs commonly at Hope and for 30 miles farther east to a point 53 miles southwest of Princeton. A pair of *ruber* had a territory at a point 61 miles southwest of Princeton; these birds were seen copulating on May 13, but their nest was not found. At 56.6 miles southwest of Princeton, a typical *ruber* was seen on May 16. At 53 miles southwest of Princeton, the western border of the burn in Manning Park, a typical *ruber* was seen and heard tattooing on May 23, and the same or another bird was seen later in the day about 200 yards away. On July 12, at almost the exact spot where the bird was seen tattooing on May 23, a typical *ruber*, possibly the same one or its mate, was

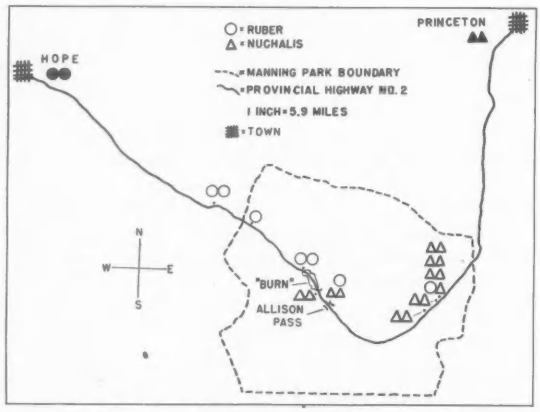

Fig. 6. Distribution of *S. v. ruber* and *S. v. nuchalis* in Manning Park area, British Columbia. Solid symbols indicate common occurrence as breeding birds of one form only. Pairs of open symbols indicate records of mated pairs, the left symbol representing the male. Single open symbols mark records of adults not definitely known to be mated.

observed gathering insects from a tree trunk in the manner of a parent obtaining food for its young. Although a nest could not be found, there can be little doubt that there was one at this locality. With two exceptions which will be discussed later, no *ruber* were seen east of the burn.

Nuchalis occurs commonly at Princeton and for 50 miles to the southwest. Three nests of *nuchalis* were found 29 miles southwest, one 30 miles southwest, one 34 miles southwest, and two 50 miles southwest at the eastern edge of the burn in Manning Park. Other Red-naped Sapsuckers were frequently seen in the intervening areas, but none was found west of the burn. However, there is one record of *nuchalis* at Hope, where a single bird was taken on May 19, 1932 (Munro and Cowan, 1947).

Two examples of *ruber* were seen east of the burn. On May 30, a typical *ruber* was seen 50 miles southwest of Princeton, where it was harassed by a pair of *nuchalis*; the following account of this incident is quoted from my field notes:

"A creek runs from the southwest into Cedar Creek at this point; on one side, the timber is almost all green, and on the other the burn starts. The small valley in which

this creek runs extends to the southwest and provides green timber for several miles, quite possibly to the other side of the burn.

"At 10:25 I saw a *nuchalis* in a dead tree on the green side of the creek. Then a typical *ruber* flew to a small balsam (= alpine fir) near me, on the burn side. The *ruber* moved on up the slope a short distance and began to feed near and even on the ground, apparently on ants, which are large and abundant. The *nuchalis,* which I am virtually certain was a male by its color, followed and alighted in a spruce at a higher level than the *ruber*. Then it flew to a small dead tree and tattooed several times; the *ruber* paid no heed. The *nuchalis* did some fly-catching, then flew down to the *ruber,* "crest" up and squawking; the *ruber* flew off a little way and began feeding again. In the next 30 minutes, this was repeated several times, the *nuchalis* aggressively tattooing, the *ruber* flying off a short distance when approached and never tattooing. The action took place over a strip of hillside about 10 yards long. The *nuchalis* flew across the road to the east slope, a distance of several hundred yards, and in a few minutes was back. Another *nuchalis* appeared, probably the mate of the first. One *nuchalis,* presumably the male and the same one each time, continued to harass the *ruber,* tattooing loudly and then flying over to it in an aggressive way, squawking and with its "crest" up. The second *nuchalis* seemed to follow along, giving an occasional tattoo. The *ruber* always flew off when the *nuchalis* came up, but seemed determined to stay in the general area; the chase went back and forth, often involving the same trees. The *ruber* stayed consistently low or on the ground, but did a bit of fly-catching. The *nuchalis* tended to stay about 20 feet up, did quite a lot of fly-catching, but went to the ground occasionally. Finally, about 11:50, the *ruber* flew far up the creek, to the southwest, and the *nuchalis* followed. They went over the shoulder of the ridge, then came up again, and worked back toward me. Again they went off to the southwest, finally across the creek to far over on the green side, where I saw the two in the very top of a dead spruce over 200 yards away. I could barely make them out. Then the *ruber* went farther southwest, and I lost sight of it; the *nuchalis* remained in the tree a few moments, then went a little to the east, and I lost sight of it too. An area with a diameter of at least one-quarter mile was involved in this activity, which lasted until 12:05."

Cedar Creek, referred to in the first paragraph, is a small stream that parallels the road in the western part of Manning Park. On July 13, a *nuchalis* nest was discovered within 100 yards of where the beginning of this incident was observed. The pair of *nuchalis* behaved neither more nor less aggressively toward the *ruber* than they did toward other *nuchalis* that invaded their territory. As the *ruber* showed only passive resistance, it is unlikely that the bird was near its own territory. A search made the next day in the direction in which it was last seen to fly revealed not *ruber* but more *nuchalis*.

On May 9 I found a male *ruber* at a locality known as The Falls, 29 miles southwest of Princeton and over 20 miles east of Allison Pass. At this point the Similkameen River and the highway are roughly parallel. The banks of the river are lined with willow, black cottonwood, and aspen, and steep slopes rise on either side. The slopes are covered principally by conifers, but there are many broad gulleys about a quarter of a mile wide that are largely devoid of live trees but which have numerous charred and dead ones, indicative of a forest fire long ago. The total impression is one of wooded ridges separated by grassy stretches with stands of dead trees. The latter areas seem to be favored by the nesting sapsuckers, although there are frequent patches of aspen among the predominant lodgepole pine, Engelmann spruce, and alpine fir. Ponderosa pine is present but very scarce; it becomes abundant at lower elevations farther east.

This example of *ruber* was not typical in that he had more white in the back and

slightly more distinct traces of striping showing through the red of the head than is usual in that race. The bird was mated to a typical female *nuchalis,* and they chose as a nest site a thirty-foot tall dead conifer stub about 400 yards up one of the open gulleys just described. Three excavations, 90° apart, were started before one was settled on. All three were about 25 feet above the ground. The final one faced north, and it is possible that it was chosen to avoid the glare of the direct sun which appeared to bother the birds at the east- and west-facing excavations. Work had begun at all three places by May 9, when I first located this pair, but after May 17 the birds worked only on the north-facing nest. Construction continued until about May 28, and the birds appeared to begin incubation about June 2. The male did much more of the construction work than the female. During the construction period, both the male *ruber* and the female *nuchalis* frequently left the nest with the curious fluttering glide and soft rattling cry that was mentioned in the discussion of life history. I also noted this among pairs of *nuchalis,* as did Saunders (1929).

As the male of this pair was the only *ruber* in the vicinity, his activities were relatively easy to follow. The female *nuchalis,* unfortunately, could not be told from the numerous others nearby. The male *ruber* had a cruising range of 400 or 500 yards down the slope and to the west side of his nest. On the east side a pair of *nuchalis* defended a territory to within about 100 yards of the nest of the *ruber-nuchalis* pair, and the slope above the nest was not often visited by sapsuckers as this portion was covered by an almost unmixed stand of lodgepole pine and the birds much preferred to work on alpine fir and western hemlock. Near the limits of his cruising range the *ruber* often encroached on the territories of pairs of *nuchalis,* and he was always driven away from these although sometimes only after several minutes of tattooing, chasing, and squawking. He in turn was quick to challenge any sapsucker other than his mate that ventured within about 150 yards of his nest site, but the territory he defended successfully was about 50 yards less extensive. Twice he behaved aggressively toward a male Red-shafted Flicker which alighted on or near his nest tree and once showed agitation when a Sparrow Hawk (*Falco sparverius*) perched 20 yards away from the site, but such reactions toward these neighboring species were not the rule. On at least one occasion the *ruber* was assisted in territorial defense by the female *nuchalis.* This was on May 11, when, after a series of tattoos, a male *nuchalis* came to within 60 yards of the *ruber-nuchalis* nest. The *ruber,* followed closely by his mate, chased the intruder away in short flights of 5 to 10 feet. The male *ruber* tattooed loudly several times, and the female *nuchalis* tattooed softly; the pursued bird did not give an answering tattoo until his own territory was reached.

Three attempts at copulation by this mixed pair were observed, but only one of these appeared to be successful. On May 20 I happened to be standing in the open about 20 yards from the female when the male approached her in the usual sapsucker fashion; she was completely receptive, but just as the male mounted her he seemed to notice me and take alarm, for he hopped off her back immediately and flew away. The female remained in the copulatory position for a moment and then began to preen. On May 27 an apparently successful copulation between these two birds was observed. On May 28, the female *nuchalis* was seen working about in some conifers near the nest. She screamed loudly several times; the *ruber* flew over to her, and they approached each other, squawking. The female then seemed to invite copulation by perching crosswise on a branch and arching her head far back. The male approached, moving lengthwise, fluttering his slightly drooping wings, squawking, and raising his crown feathers. He did not mount her, however, although there was no apparent disturbance, and this time I was well hidden.

Between May 28 and June 2, the birds apparently stopped excavating the nest, for they no longer tossed out beakfuls of chips while inside it, but they continued to take turns staying in the nest. I assumed that egg laying and incubation had started, and on June 4 I left to investigate areas farther north. I returned on July 11 hoping to find young still in the nest or close by, but no trace of the parents or their possible offspring was found although I searched for three days. Hence, it is not known whether this nesting was successful or not.

The limits of the ranges of the two subspecies are sharply defined in the Hope-Princeton region, but the habits and behavior of both forms appears identical. Each race occupies a different biotic area and each is replaced by the other at the junction of those areas. However, several species of trees which are utilized by sapsuckers for food and nest sites are common to both areas, and it is difficult to believe that one race finds the biotic area occupied by the other wholly unsuitable ecologically. Nevertheless, replacement of one race by the other is abrupt and with little or no interbreeding. It may be that ecologic preferences or adaptations which are more clearly discernible in the climax portions of the two biotic areas are reinforced sufficiently by a slight geographic barrier at the junction of the two areas to block intermingling of the races at that point.

Cariboo area.—From June 8 to July 9, 1950, I carried on field studies in the central interior of British Columbia in the region along the Fraser River which is known as "The Cariboo." It is flat or gently rolling country without sharp changes in elevation, and most of it lies within the sub-alpine forest biotic area of Munro and Cowan (1947). Part of the central interior, with northern and southern limits roughly at Soda Creek and Clinton, respectively, has been designated by these authors as the Cariboo parklands biotic area.

The most conspicuous trees in this area are lodgepole pine, Douglas fir, black spruce (*Picea mariana*), birch, and aspen; the latter two are found together in dense stands. The sapsuckers are especially partial to birches for feeding and to aspens for nesting; all the thirteen nests I observed in the Cariboo were in aspens.

Between June 23 and 27 I followed Provincial Highway No. 2 to what was then its end point about 67 miles north of Prince George. I had hoped to find *S. v. varius* at that latitude, but I was unsuccessful.

Most of my time was spent at Alexandria, 28 miles south of Quesnel, and at Kersley, about 15 miles south of Quesnel. Another locality at which many observations were made was McLeese Lake, south of Alexandria and about 20 miles north of Williams Lake.

Weeks of field work may be summarized by stating that, with two exceptions, all the sapsuckers found south of Kersley were typical *nuchalis* and all those found north of Kersley were typical *ruber*, and at the juncture of the ranges of the two races a very small amount of interbreeding took place. Within 1.5 miles, one form was completely replaced by the other. At least four adults of *ruber* were found at Kersley, and three north of there; at least five *nuchalis* were found at Kersley, and at least fifteen south of there.

More examples of *nuchalis* were seen than *ruber*, but this is probably due to the fact that I was staying at Alexandria and working north from there to the range of *ruber*. Since *ruber* had been reported as abundant in the immediate vicinity of Quesnel (Cowan, personal communication) and since almost as many *ruber* were observed at Kersley as were *nuchalis*, it is probable that the former race was as abundant north of that locality as *nuchalis* was south of it.

The two exceptions mentioned were a male *ruber* at Alexandria which was mated to a female *nuchalis*, and a male type 6 (MVZ no. 120932) at McLeese Lake which was

also mated to a female *nuchalis* (MVZ no. 120935). The coloration of the latter male is predominantly like *ruber*, but there is a trace of black and white facial pattern, and the red of the breast extends only far enough to cover the underlying black pectoral patch, so that the red is sharply demarcated from the yellow of the abdomen. Both these nests were completely successful. The male (MVZ no. 120933) and two of what seemed to be four young of the mixed pair at Alexandria were collected; the female was shot but not recovered. One of the young birds, a male (MVZ no. 120930), is indistinguishable from a juvenile of typical *ruber*, but the other, a female (MVZ no. 120931), shows

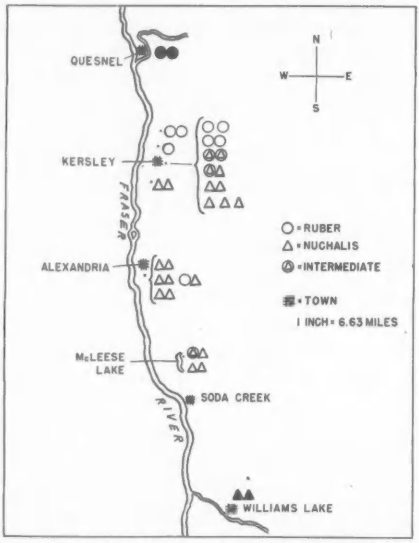

Fig. 7. Distribution of *S. v. ruber* and *S. v. nuchalis* in the Cariboo Region, British Columbia. Symbols as in figure 6.

intermediate characteristics. Both the parents and all four young (MVZ nos. 120936–120939) of the pair at McLeese Lake were also collected, and these young are variously intermediate but are closest to *nuchalis* in pattern. Except for these two adult males and their offspring, all the sapsuckers seen south of Kersley were typical *nuchalis*.

At Alexandria three nests of *nuchalis* were found in addition to the nest of the mixed pair, and numerous other *nuchalis* were seen in the vicinity. At a point 17.5 miles south of Quesnel, a nesting pair of *nuchalis* was collected. The male (MVZ no. 120921) is atypical in that the white postocular stripe is replaced by black, but this could scarcely be considered an indication of intermediacy toward *ruber*. *Nuchalis* was found farthest north at a point 14.7 miles south of Quesnel, in the vicinity of Kersley, where a nesting pair was collected.

One of a nesting pair of typical *ruber* was collected 10 miles south of Quesnel. At a point 12.7 miles south of Quesnel, a *ruber* was seen on June 13 but it could not be traced to a nest.

The following observations were made in the immediate vicinity of Kersley, but as the borders of this small town are rather indefinite the localities are given as miles south of Quesnel, measured by speedometer.

A typical *ruber* was seen at close range 14.8 miles south of Quesnel on June 19. On June 20, 16 miles south of Quesnel, I found a nesting pair of sapsuckers which showed mixed characteristics of *ruber* and *nuchalis*. At this time they were busy feeding their vociferous young. On June 28 this pair was again observed feeding their noisy brood. The parents were collected on July 7 and 8, after the young had already emerged. In both cases the adults were attracted to the nest from at least 50 yards away by imitation tattoos given within 10 yards of the nest tree. Both sexes responded with loud tattoos after the first few imitations. The male is the redder of the two, and represents type 6 (MVZ no. 120941); the female represents type 5 (MVZ no. 120940).

On June 28 another nest was found not over 400 yards from the one described above. The adults were seen at close range, and one was an intermediate between *nuchalis* and *ruber* and the other appeared to be typical *nuchalis*. I was able to locate this nest by the loud cries of the young, of which there must have been several. On July 6 the nest was empty and an unsuccessful attempt was made to collect the intermediate parent; this bird was not seen again. The next day I found three juveniles at a birch "feeding tree" about 50 yards from the nest. An adult *nuchalis* came and fed them several times. On July 8 an adult female *nuchalis* flew to this spot and tattooed on a dead branch in reply to my imitations and was collected. Although not certain, it is likely that this female was the mate of the intermediate, which would therefore be a male, and that the juveniles were their offspring.

About 100 yards south of this nest, on July 7, I found a *ruber* tattooing loudly on a dead stub. I shot and wounded this bird, but unfortunately I was unable to recover it.

At a point about half way between the two nests involving intermediate birds, the following incident occurred on July 8, and it is quoted verbatim from my field notes: "a loud tattoo came from the top of a tall dead tree right overhead. The sky was overcast with haze, and I could not see very well as far as colors go. There were more tattoos, and I noticed a group of at least 3 juveniles lower down, all of which looked like *nuchalis*. An adult *nuchalis* came up and chased a juvenile, and a large juvenile seemed to do some chasing itself. Then, suddenly it seemed, there was a wave of sapsuckers involving at least 5 juveniles and 4 adults—possibly two family groups. The adults worked very high, going from dead-tree-top to dead-tree-top, tattooing and screaming, and squawking when two or more got together. Once 4 adults were at the top of the same dead tree. I was sure I saw one *ruber*, possibly more, and am positive of 3 *nuchalis*. The juveniles all had at least some head-striping. Suddenly, the birds stopped tattooing and dispersed, and all was quiet."

A few minutes later I was attracted to another nest about 300 yards away from both others by the loud cries of a nestful of young at least three weeks old. The parents were collected at the nest—both typical *ruber*.

Thus, within an area about 400 yards in diameter the following were found nesting: a pair of typical *ruber*, a pair with mixed characteristics of *ruber* and *nuchalis*, and a pair that seemed to consist of a male intermediate and a female *nuchalis*. In addition, at least three other *nuchalis* were seen here and at least one other *ruber*, as well as five or more juveniles of indeterminate parentage. 1.3 miles farther north a pair of typical *nuchalis* was collected, but all other sapsuckers seen north of 16 miles south of Quesnel were typical *ruber*. All the nests were in exactly the same type of woodland and all were about 25 to 40 feet above the ground in large aspens.

Munro (1945) places the northern limit of the Cariboo parklands at about 9 miles north of Williams Lake. Munro and Cowan (1947) state that "to the north it [Cariboo parklands biotic area] merges into the sub-alpine forest." An exact boundary would

probably be arbitrary, but as McLeese Lake, Alexandria, and Kersley are from 12 to 27 miles north of the one given by Munro (1945), it is virtually certain that the mixed pairs and intermediates did not occur where the gradient between the Cariboo parklands and sub-alpine forest biotic areas is steepest. There seemed to me to be no perceptible change in ecology or geography at Kersley which might influence the sapsuckers, and there is certainly no abrupt transition from one biotic area to another. None of the trees utilized by the sapsuckers for food and nest sites reaches the limits of their ranges there, and nothing in the physical appearance of the terrain suggests a limiting factor. As in the Hope-Princeton region, there was no noticeable difference between the races in any aspect of behavior. In contrast to the Hope-Princeton region, however, there are no sharp changes in environment or topography at this point in the Cariboo region where *nuchalis* and *ruber* meet.

It is possible that the general ranges of the races in this area—*nuchalis* in the Cariboo parklands and *ruber* in the sub-alpine forest to the north—are in some measure the result of habitat preference or ecologic suitability, but it is very difficult to account for the abrupt replacement of one form by another in an area of apparently uniform environmental conditions on such a basis. The possibility that an extremely narrow zone of equilibrium between the two races has been established through differential survival in a habitat in which conditions are not optimal for either subspecies cannot be ruled out, but at present there is no evidence that the habitat in which one race is replaced by another is one in which the reproductive potential or viability of either of the races is lowered. On the contrary, the presence of numerous breeding sapsuckers of both races in this habitat, especially at the point where the ranges of the two meet, is evidence that the environment is quite suitable to both.

DISCUSSION OF RELATIONSHIP AND ISOLATING MECHANISMS

In the foregoing discussions, the sapsuckers studied have been treated as members of a single polytypic species. The reasons for regarding them as such should now be examined. No one criterion is necessarily sufficient for classifying forms as races or as species, but criteria which, considered jointly, are commonly regarded as a good test of the kind of relationship involved are as follows: 1) allopatry or sympatry, 2) similarity or difference in behavior and life history, and 3) interbreeding in nature with the production of fully viable and fertile offspring, or failure to do so. Information on these three points is available for the sapsuckers and has been presented in the preceding sections of this paper, but a brief summary is in order.

Examination of ranges of the sapsuckers as given previously shows that the four forms studied are allopatric, as they occupy breeding ranges that are geographically complimentary. Zones of interbreeding, if present, are usually narrow, but in other respects the geographic picture is similar to that found in many avian polytypic species.

The life history of the forms, including food habits, vocalization, and the critical factor of breeding behavior, is almost identical except for differences in migration. The latter topic will be treated subsequently; at this point it suffices to mention that variation in migratory tendency is found among many unquestioned subspecies such as the races of the Song Sparrow (*Melospiza melodia*) and the Allen Hummingbird (*Selasphorus sasin*).

Evidence has been presented to show that between *S. v. daggetti* and *S. v. ruber* there is extensive interbreeding; between *S. v. nuchalis* and *S. v. daggetti*, and probably between *S. v. varius* and *S. v. nuchalis* there is definite but not unlimited interbreeding; between *S. v. ruber* and *S. v. nuchalis* and between *S. v. ruber* and *S. v. varius* interbreeding appears to be extremely scarce and does not seem to occur invariably where

their breeding ranges meet. All intermediates between *S. v. daggetti* and *S. v. nuchalis* and between *S. v. ruber* and *S. v. nuchalis* which were studied seemed fully viable and fertile, and an intermediate between *S. v. ruber* and *S. v. varius* has been observed in the early stages of nesting. There is, therefore, no evidence that intermediates between the different forms are less viable or fertile than typical examples of any of them.

Considering the information presented above, the relationships of these sapsuckers seem to be best expressed taxonomically by classifying them as subspecies of a single species, as has been done by the majority of recent authors. On the other hand, it is apparent that relationship is not equally close between all the races and that interbreeding between the contiguous ones is not as extensive as in most subspecies. What, then, are the factors restricting interbreeding between the races?

Physical and geographic barriers such as the Great Plains, the Great Basin, and some of the western mountain ranges clearly prevent contact between the races over large areas, but it is highly doubtful that similar barriers in the form of habitat unsuitable for sapsuckers are alone responsible for the differences in the amount of interbreeding that occurs where the subspecies do meet one another. There is some evidence that unfavorable terrain inhibits interbreeding between *S. v. nuchalis* and *S. v. daggetti* in California and between *S. v. nuchalis* and *S. v. ruber* in Oregon, Washington, and southern British Columbia, but in another place where *S. v. nuchalis* and *S. v. ruber* meet and in instances of contact between *S. v. varius* and *S. v. ruber,* in which interbreeding is extremely limited, physical barriers may be non-existent.

There is no evidence of physical incompatibility between any of the subspecies. *S. v. ruber* averages larger than the other three, but there is considerable overlap between its dimensions and those of the other races.

There must be some differences in habitat preference or adaptation to environment between subspecies of *S. varius* or one would have to assume that such distinct geographic differentiates were purely the result of random fixation of non-adaptive characters developed in sufficiently small and rigidly isolated populations. This may have occurred in the formation of some insular forms, but it is highly unlikely that the wide-ranging continental subspecies of *S. varius* developed in such a way. Ecologic differences between the races are therefore of probable importance in limiting interbreeding between them through effecting differential survival and reproductive potential in areas where the breeding ranges of the races meet.

If only ecologic factors are operative, and if intermediate birds are fully viable and fertile, one might expect that as the ranges of two subspecies approach one another the characters of the races would blend in a gradient proportional to the steepness of the gradient of change between their respective habitats. If one type of environment merges almost imperceptibly into another, a wide zone of intergradation between the races is to be expected; if the environment changes more abruptly, an equally abrupt replacement of one form by another may be looked for. In the event that the ranges of two races meet in an area between their optimum habitats, in an environment to which neither is significantly better adapted than the other, a broad zone of intergradation would be expected if both forms are moderately successful in such a region or a narrow zone through scarcity of breeding individuals might develop. In any of the above situations, a physical or geographic barrier in the area of environmental change would further restrict interbreeding, and a combination of the foregoing factors could bring zones of intergradation to very narrow limits.

As there is much evidence that intermediates between the races of *S. varius* are fully viable and fertile and no evidence except their scarcity that they are not, it may be asked

whether factors other than degree of ecologic difference and geographic barriers need be invoked to account for the variation in interbreeding between these subspecies. The following discussion of the forms, race by race, attempts to provide an answer.

It appears that, at least in the western part of its breeding range, *S. v. varius* prefers or is better adapted to somewhat open stands of deciduous trees, particularly aspen and birch, than to mixed deciduous and coniferous forest. Cowan (1939) found *S. v. varius* more abundant in climax type aspen forest than in dense stands of second growth aspen (in which the trees are probably too small to provide suitable nest sites) or mixed aspen and spruce in the Peace River district of British Columbia. He did not find this race in pure coniferous forest. Munro and Cowan (1947) report *S. v. varius* as common in the aspen associes of the boreal forest biotic area in British Columbia. Swarth (1922) found only two typical examples of *S. v. varius* at Telegraph Creek, and those that he found were nesting "... in a dead birch in rather open woods." This locality is very close to if not actually at the western limit of the range of *S. v. varius*. Soper (1949), in a portion of northwestern Alberta, found this race most numerous in the area adjacent to the Peace River parklands of British Columbia; it is not clear from his paper whether the birds were found in mixed coniferous and deciduous woods or in primarily deciduous stands. Soper did not find *S. v. varius* or any other sapsucker in the higher country along the eastern edge of the Rocky Mountains; it may be that farther south where it seems to be rare (Rand, 1948), *S. v. varius* also finds higher elevations unsuitable in some way.

S. v. nuchalis appears to breed primarily in mixed coniferous and deciduous forest containing aspen, but the race may nest in almost pure stands of either forest type. In the mountainous country between Hope and Princeton, British Columbia, *nuchalis* was found far more commonly in open stands of conifers than in the aspens and cottonwoods along creeks and rivers, but at Dry Lake, 15 miles north of Princeton, this race was found nesting only in the aspens and cottonwoods around the lake and not in the conifers. In the Rocky Mountain region *nuchalis* seems to nest primarily in aspen groves (Bailey, 1928, and Bent, 1939); in the Cariboo region of British Columbia the race was found nesting only in aspens but in both mixed and unmixed stands of this tree. *Nuchalis* is never found breeding in the humid coast area or anywhere west of the Cascade Range, and it seems likely that ecologic differences and the barrier formed by the higher elevations of the Cascade Range are largely responsible for the extremely limited interbreeding between *nuchalis* and *ruber* in Oregon, Washington, and southern British Columbia. The relation between these two races in the Cariboo region will be considered in the discussion of the ecology of *ruber*.

Over a large part of their breeding ranges, *S. v. nuchalis* and *S. v. daggetti* are found in very similar habitats of mixed coniferous and deciduous forest, but *S. v. nuchalis* in addition breeds in areas of generally higher elevation and of higher latitude than does *S. v. daggetti*. There is also evidence that *nuchalis* winters in some parts of the Sierra Nevada that have been vacated by *daggetti* (Grinnell and Storer, 1924).

As higher latitudes and higher elevations have in common lower extremes of temperature than occur in more southern and lowland areas, there may be a difference between these races in their tolerance of the environmental conditions associated with such temperatures. *Nuchalis* appears to have a wider range of tolerance to these conditions, as it breeds both in habitats closely similar to those in which *daggetti* breeds and also at higher elevations and farther north; but *daggetti* may have some adaptive advantage over *nuchalis* in the Sierra Nevada region. In any event, the two forms are largely isolated by the Great Basin, and there are minor discontinuities in suitable habitat separating them at least partially in Modoc County, California, which is the principal zone of

contact between *daggetti* and *nuchalis*. In this region there is moderate interbreeding between the two, and it is quite possible that a combination of the ecologic and geographic factors have limited this interbreeding to its present extent.

S. v. daggetti breeds across northern California into the coast region from Mendocino County, California, to Josephine County in southern Oregon. Between Josephine and Coos counties, Oregon, *daggetti* is replaced by *ruber*. Little is known of the relative abundance of the birds in the zone of intergradation. Birds from the extreme northern coast of California are often darker than typical *daggetti*; Gabrielson and Jewett (1940) state that breeding sapsuckers of the Rogue River Valley are much closer to *daggetti* than to *ruber*, and that those from Coos County north are typical *ruber*. In view of the fact that *ruber* is primarily a humid coast race and *daggetti* primarily an interior forest type, it is likely that ecologic differences play a large part in the replacement east of the coast forest of one race by the other. *Daggetti* may reach the limit of its optimum habitat in the Klamath Mountains and give way to *ruber* north of that region. No data are available on how abruptly one form is replaced by the other. However, the general darkness of *daggetti* from the extreme northern California coast (birds from this area were once considered to represent *ruber*) indicates that the two races may exhibit little if any reproductive isolation where their ranges meet along the coast. This is what might be expected in the absence of abrupt change in habitat or major geographic barriers.

The ecology of *S. v. ruber* is puzzling in that this sedentary race, with a center of distribution in the humid coast forests of the Pacific Northwest, is an abundant and successful breeding bird in the summer-dry interior forests of north-central British Columbia east of the Cascade and Coast Ranges, and at least one pair has reached the climax aspen forest east of the Rocky Mountains. Although there can be little doubt that this race as a whole is better adapted to the humid coast than are the other races, its adaptations do not seem to put it at a disadvantage in the interior. It is difficult to see what adaptive advantage *ruber* has over *varius* in the north-central interior or over *nuchalis* in the Cariboo region. It is quite possible, of course, that populations of *ruber* that breed in the interior do not have the same adaptations or preferences as the coastal breeders. This could account for the success of *ruber* in areas outside the "typical" habitat of the race, but it still does not explain the great restriction of interbreeding of *varius* and *nuchalis*.

Many essentially eastern species and subspecies of passerines are found over the north-central interior of British Columbia, where they meet related western species or races from the south-central interior. One might expect that *varius* and *nuchalis* would meet and interbreed somewhere in the broad area which instead is occupied by *ruber*. The two known instances of the meeting of *ruber* and *varius* have been discussed previously, and it may be that ecologic factors are important in limiting interbreeding between these races. The relation of *ruber* to *nuchalis* in the Cascade region seems accountable on the basis of ecologic differences and geographic barriers in the form of terrain unsuitable for either race. The relation between these two races in the Cariboo region is much less easily explained, for as pointed out in an earlier section there are no geographic barriers and the influence, if any, of ecologic factors is too subtle to be readily apparent. Nevertheless, replacement of one race by the other is abrupt and with a minimum of interbreeding. In this instance the possible influence of factors other than those mentioned above should be explored.

One possible factor is the homing tendency of the intermediates. When non-migratory races interbreed freely, the zone of intergradation is usually broad and constant as the intermediate offspring spread their characteristics in both directions into the parent

populations until an equilibrium in gene flow is reached. On the other hand, when one or both interbreeding races are migratory, many intermediates may not return to breed within a few territories of the area in which they were raised. If these intermediates wander rather widely and breed within a pure population of one or the other race, their mixed characteristics will probably be largely swamped within a few generations. The narrower the zone of intergradation, the less chance there is of an intermediate returning to it in the spring unless the homing tendency is very strong. This tendency is well marked among some intermediates at least, or there would be no stable area where birds of mixed characteristics may be found year after year as they are in part of Modoc County, California. On the other hand, some birds of mixed heritage do breed outside the usual zone of intergradation between two races; examples are the *ruber* with traces of *nuchalis* ancestry at McLeese Lake, British Columbia, and the two intermediate birds from a large population of pure *nuchalis* in the Warner Mountains in California. As homing instinct in intermediate birds is certainly not infallible, the zone of intergradation is doubtless narrower between the races of sapsuckers which leave their common breeding grounds in the fall than it would be if both races were resident there. This would be true, of course, only when limited interbreeding is involved; otherwise dispersal resulting from migratory movement of numerous intermediates would tend to broaden rather than restrict the zone of intergradtion. It is perhaps significant that among the essentially resident coastal populations of *daggetti* and *ruber* there is a broad zone of intergradation, although sedentariness is certainly not the only cause.

An important physiological factor is the difference in migratory tendency between the races. *S. v. varius*, it will be recalled, is highly migratory, *S. v. nuchalis* less so, *S. v. daggetti* still less so, and *S. v. ruber* almost not at all. For a bird that depends for food on fruits, berries, soft parts under the bark of trees, running sap, and active, exposed insects, a severe winter climate presents great difficulties. Whatever the basic cause, migration to a milder temperature zone in winter is of great selective advantage to such a species. In eastern North America, *S. v. varius* moves south, often far beyond the southern limits of its summer range. In western North America, *S. v. nuchalis* and *S. v. daggetti* can to some extent substitute altitudinal for latitudinal migration in the southern parts of their ranges. This is especially true of *daggetti*, for the equable climate of the California coast is close by. As the range of *ruber* is largely in a coastal region where winters are not too severe to prevent sapsucker feeding, most members of this race can remain in the same area the year around.

The movements of the populations of *ruber* inhabiting the interior are poorly known. All winter records of this race in British Columbia are from the coast, but this may reflect a lack of field work in the interior at that season rather than an absence of the birds. The fact that winter temperatures may be below —50°F. in this region even at elevations between 1000 and 2000 feet makes it seem doubtful, however, that many sapsuckers remain there during the cold months. The paucity of field observers is likewise understandable.

When migrating *S. v. varius* and *S. v. nuchalis* return to northwesterly areas in the early spring, it is entirely possible that their advance is eventually checked by the presence of the essentially non-migratory *ruber*, already on its nesting territories but not necessarily ahead of the other races in breeding activities. If *ruber* leaves the interior for the coast in the winter, these birds may move northeast and occupy territories before the arrival of the other races from the south. The north-south relation of *ruber* to *nuchalis* in the Cariboo region of British Columbia is explicable on this basis, as is the fact that *ruber* may occasionally breed within the usual range of *varius* and *nuchalis*, whereas

the latter two races have never been found breeding within the usual range of *ruber*. If *ruber* does pre-empt territories in such a way, this would account for the sharp lines of demarcation between the subspecies as opposed to the mixture of races over a relatively wide area which would occur if two highly migratory forms arrived in the same region at the same time. It would also follow that opportunities for interbreeding would tend to occur along a line rather than in depth, and mixed matings would consequently be much restricted. Unfortunately, this hypothesis can be verified only by intensive observation in interior western Canada in late winter and early spring, a time at which field work is most difficult.

Finally, there is possibly a psychological factor acting to limit interbreeding between the races of sapsuckers. In the four mixed pairs that were studied, three involving typical or almost typical *ruber* and typical *nuchalis*, and one involving typical *daggetti*, an intermediate, and a typical *nuchalis*, the male bird was of the race with the most red, that is, *daggetti* or *ruber*. In a mating involving intermediates of *ruber* and *nuchalis* the male of the pair was the redder, and an intermediate between these two races which was mated to a typical *nuchalis* was almost surely a male. In four matings involving intermediates of *daggetti* and *nuchalis* in which the sexes were identified, the redder bird was the male in each instance. In the one known pair in which a *varius* was mated to an intermediate, the male was typical *varius* and the female was the intermediate (*varius* x *ruber*) and therefore redder than the male. Thus, in four matings involving birds of different races, the males were the redder, and in matings involving birds of different and mixed racial stock, including the type 5 female in the threesome, the males were the redder in seven out of eight instances. These data suggest that the amount of red in the plumage may be a factor in courtship and mate selection in *nuchalis* and intermediates between *nuchalis* and *daggetti* or *ruber*. If so, this is probably the case with *S. v. varius*, a race which shows sexual dimorphism also, although the only exception to the male being redder than the female in mixed matings involves a cross of *varius* and *ruber*.

A female *nuchalis*, for example, might be receptive to a male *daggetti* or *ruber* but a female of one of the latter two races might not be receptive to, or especially might not be courted by, a less-red male *nuchalis*. The same reasoning may apply to *S. v. varius* in relation to *S. v. nuchalis* and *S. v. ruber*, the females of which are much redder than those of *varius*. A male of *ruber* or *daggetti*, on the other hand, belonging to a race in which sex recognition cannot depend on color, might be expected to respond to reproductive behavior in females of the less-red races, since such behavior does not differ from that of the redder ones. This has been observed and described previously in this paper.

If the foregoing hypothesis is correct, the effect of such reactions would be to reduce mixed matings to one-half the number which would be expected to occur if an equal number of males and females of two different races mated at random. One can hardly expect mate selection between the races to apply so strictly, but it may be a means by which partial reproductive isolation is maintained or augmented.

It is not unreasonable to suppose that red coloration is of some importance in the mating behavior of *Sphyrapicus varius* and in other woodpeckers as well, for in practically all the Picidae sexual dimorphism in color is manifested principally by the presence or greater extent of carotenoid pigment, especially red, in the male. The most obvious significance, since such coloration in woodpeckers is neither protective nor disruptive, or no more so in the male than in the female, would lie in sex recognition for reproductive behavior (Noble and Vogt, 1935). The objection might be raised that if sexual dimorphism in color is of importance in the mating activities of sapsuckers, why should

it be lacking in *daggetti* and *ruber*? The best explanation is that other characters of greater selective advantage are in some way associated or linked with the heavier pigmentation that obscures sexual dimorphism in these races.

There is, then, some evidence that by influencing mate selection the color differences between the races of *S. varius* may serve to maintain or augment partial reproductive isolation. Thus, color differences such as those between the races of sapsuckers, regardless of any other importance the differences might have, may contribute to the origin of new forms by acting to reduce gene flow between populations. Color differences among these subspecies may therefore be of some evolutionary significance other than as a part of geographic variation.

Significant or not, the color variation can be accounted for most simply and reasonably on the basis of minor and cumulative genetic changes, for steps by which color differences may have developed are clearly discernible in these birds. The question then arises as to how the populations became sufficiently isolated for their respective differences to have become established, and this necessitates a consideration of the possible history of the group.

HISTORY OF SPHYRAPICUS VARIUS

The genus *Sphyrapicus* occurs only in North America, and there seems to be no reason to suppose that its range ever extended to other continents. The distribution of the group does not seem in any way to be restricted by competition with other species. Sapsuckers construct nests frequently in areas where other woodpeckers are abundant. The sap- and cambium-eating habits, which make up at the very least sixteen per cent of the diet (Beal, 1911), are virtually unique and are not confined to any major or minor group of trees or shrubs. The only insect group that seems to be preferred to others is the ants—a group of cosmopolitan distribution and great abundance.

If the genus ever occurred outside of North America or if it originated elsewhere, as appears to be true in the case of *Dendrocopos* (Voous, 1947), it is difficult to see why it should not be found elsewhere today. Indeed, it is difficult to see why *Sphyrapicus* is not more widespread in North America than it is, for *S. varius* is able to get along well in México and Central America during the winter months, and trees—at least dead trees —suitable for nesting sites are certainly available there. As *Sphyrapicus* is widely successful in its present range and since within that range it is not restricted to a highly specific habitat, there is little reason to regard its distribution as relictual.

The feeding habits of *Sphyrapicus* mark the genus as a specialized one, and this impression is confirmed by the anatomical studies of Burt (1929, 1930). Burt points out that *Picoides, Dendrocopos* and *Sphyrapicus* have similar adaptive modifications by which they have achieved greater specialization for arboreal life than any other genera of North American woodpeckers. He also demonstrates that *Sphyrapicus* is aberrant in pterylography and offers an interesting opinion on the reduction of the capital apterium in this genus. "If, as appears to be the case, this apterium was brought about, in the evolution of the race, by the presence of the hyoid bones beneath the skin, through pressure or some other agency, it seems that the condition of shorter hyoids in *Sphyrapicus* is a reduction of what were at one time better developed structures, and that the vestige of an apterium is a character rapidly disappearing in *Sphyrapicus*." (Burt, 1929:434).

Sphyrapicus, then, is probably not primitive and has as its closest relatives *Picoides* and *Dendrocopos* (including *Xenopicus*). *Picoides*, according to Burt (1930) is the North American genus most specialized for arboreal life; it is also unusual in having yellow and not red markings on the head, and in having only three toes on each foot. *Sphyrapicus* also has yellow in its plumage, but never on the head, and it has four toes

on each foot as do all other North American picid genera except *Picoides*. *Sphyrapicus varius* and the American species of *Dendrocopos* are roughly similar in plumage in that they all have red markings on the head, a black and white facial pattern (concealed in *S. v. daggetti* and *S. v. ruber*), and body, wings, and tail variegated with black and white. The male *S. thyroideus* is much blacker than *S. varius*, but not as black as *D. albolarvatus*; the barred back of the female *S. thyroideus* is matched by that of *D. scalaris*, *D. nuttallii*, and *D. borealis*. These color and pattern resemblances are hardly reliable tests of relationship, however; they are mentioned merely to show that *Sphyrapicus* is as similar in coloration to *Dendrocopos* as it is to *Picoides*.

The tongue of *Sphyrapicus*, as mentioned earlier, differs from that of all other picid genera in that the hyoid elements do not extend beyond the occiput, and in that it is armed only with fine hair-like spines which give it a brushy appearance. Lucas (1895) noted a similarity in the tongue bristles of adult *Sphyrapicus* and those of a fully-fledged nestling of the Downy Woodpecker (*Dendrocopos pubescens*), but the latter was apparently only one of a very few juveniles available to him. A comprehensive survey of the tongues of both adult and young picids has not been made to my knowledge, and consequently it is not known whether the adult sapsucker tongue resembles especially that of the juvenile of any particular genus. However, the sapsucker tongue may have developed in the following way. A mutation or mutations causing arrested development of the tongue at the juvenal stage in some other genus would result in a tongue resembling that of the adult *Sphyrapicus*. A woodpecker so endowed would not be ill-adapted for feeding on exposed and flying insects and sap and cambium; it would certainly be ill-adapted for a diet of wood-borers. Would such a bird be able to alter its feeding habits? Other woodpeckers are known to feed from sapsucker workings, and the Downy Woodpecker has been observed drilling rows of holes in bark and eating sap from them (Forbush, 1921). Townsend (1932) criticized the accuracy of most reported instances of such behavior by the Downy Woodpecker, but the foregoing reference, which offers eye-witness accounts and a photograph, was apparently unknown to him. The answer, then, should probably be in the affirmative.

In view of the fact that one member of the genus *Dendrocopos* occasionally feeds in a *Sphyrapicus*-like manner, and since *Sphyrapicus* resembles *Dendrocopos* more closely anatomically than it does any other North American genus, including *Picoides*, one may reasonably propose that the genus *Sphyrapicus* has developed from *Dendrocopos* or a *Dendrocopos*-like form, and that the tongue differences may have arisen through a process resembling paedomorphosis.

Today there are two polytypic species of *Sphyrapicus*, *S. varius* and *S. thyroideus*, which occupy the same range over much of the western United States but in different ecologic situations. How these two species differentiated and whether or not there were others in the past are matters of pure speculation which it does not seem profitable to pursue unless much more evidence than is now available comes to light.

Differentiation in the species *Sphyrapicus varius* is more hopeful of elucidation, for intraspecific variation is arranged into well marked, but not completely discontinuous, racial groups. At one variational extreme is *S. v. varius*, highly migratory and showing the least pigmentation and the most sexual dimorphism. At the other extreme is *S. v. ruber*, essentially sedentary, most heavily pigmented, and without sexual dimorphism in color.

One might postulate that *ruber* is the most recently developed race of *S. varius* (a reasonable proposition, as will be shown later), and that its characteristics represent the culmination of a trend toward decline in migratory tendency and toward heavier pigmentation and consequent reduction in sexual dimorphism. This suggests that *S. v.*

varius, at the opposite extreme of the trend, is the oldest of the races, and that the sequence of racial development has been from *S. v. varius* to *S. v. nuchalis* to *S. v. daggetti* to *S. v. ruber*, for the middle two, in the order listed, show progressive change toward the characteristics which reach their extremes in *S. v. ruber*. Such an hypothesis is by no means the only possible one, however; the sequence could have proceeded in the opposite direction. Still another possibility, which seems most reasonable and least presumptuous to the author, is that the characteristics in *S. varius* which are now segregated into distinct racial groups were formerly less strongly developed and distributed along a cline. In other words, there may have occurred at one time, across most of that part of the North American continent habitable for sapsuckers, almost continuous populations of *S. varius* with characteristics similar to those now found in the races arranged in a smooth gradient from east to west. Then, if such continuously interbreeding populations were broken by some agency or agencies into partly separate groups, the eventual result would be breaks or steepenings in the formerly smooth gradient of characteristics. If enough isolation developed between populations, the species would be differentiated into recognizable subspecies.

Do historical events justify the contention that the differentiation of *Sphyrapicus varius* may have occurred in this way? The following evidence is submitted. Paleobotanical information is from Axelrod (1948) unless otherwise noted.

In Miocene and Lower Pliocene time, the forests of most of western North America where sapsuckers now occur appear to have been of generalized composition, including trees now found in the Redwood, Sierra-Cascade and Rocky Mountain forests and species whose closest counterparts are at present found in eastern North America. As many modern genera of birds are known as far back as the Miocene (Howard, 1950), it is not unreasonable to suppose that *Sphyrapicus* was in existence at least by Lower Pliocene. In view of the fact that the topography, climate, and vegetation of western North America were not as highly differentiated at the beginning of the Pliocene as they are today, it is entirely possible that a forest-dwelling bird such as *Sphyrapicus varius* may have shown variation only along an east-west cline in the early part of that epoch instead of forming a chain of distinct races geographically isolated from each other over most of their ranges. In western North America in the Middle Pliocene, however, there was large-scale mountain building, a lessening of summer rain, and a great reduction in the eastern elements of the flora. It was during this period that the flora of the present Great Basin area acquired a semi-desert character which made it largely uninhabitable for sapsuckers. Progressive aridity in the west continued in the Upper Pliocene, and the forests of the Coast Ranges, the Sierra-Cascade Range, and the Rocky Mountains were segregated into associations similar to those found in these areas today. Thus, in the Upper Pliocene there might have been three groups of sapsucker populations—one group east of the Great Plains, one group in the Rocky Mountain region, and one in the Sierra-Cascade and Coast Ranges. These three groups would have been geographically isolated from one another in all but the northern parts of their breeding ranges by the Great Plains and the Great Basin. By the end of the Pliocene, then, the species *Sphyrapicus varius*, showing variation along an east-west cline, may have been divided into the progenitors of the races *varius*, *nuchalis* and *daggetti-ruber*. How far differentiation might have proceeded by this stage can only be guessed. However, as climatic and floral conditions in western North America began during this epoch to approach those found in that region today, it is likely that any differences between the populations in adaptation to their environments or in habitat preference were initiated or, if already incipient, further developed in Middle and Upper Pliocene.

During Pleistocene glaciation possible northern contacts between the populations would have been displaced and perhaps reduced or broken. If broken, they may have been re-established during interglacial periods and then been separated by another descent of the ice. The glacial period most likely to have isolated sapsucker populations completely was the Wisconsin, which immediately preceded the Recent and during which the ice sheet reached its maximum extent. At this time the southern edge of the glacier was in the northern part of Washington, Idaho, Montana and North Dakota, and the ice covered most of the area between the Missouri and Ohio rivers and the New England states (Flint *et al,* 1945). Clearly, if the Great Plains, Great Basin, and Columbia Plateau regions were no more forested than they are today, the eastern, Rocky Mountain, and Sierra-Cascade sapsucker populations would have been completely isolated from one another.

Such a convenient biogeographical situation is far from certain, however. A narrow strip of forest may have extended along the edge of the glacier (Gleason, 1922), or an expanse of tundra with or without a forest beyond it may have been present (Sears, 1935; Deevey, 1951). Evidence bearing on the Great Plains, Columbia Plateau and northern Great Basin is scanty. Most studies on late Pleistocene floras have been concerned with other areas, and papers on analysis of pollen deposits in these regions such as that of Hansen (1947) deal largely with postglacial floras. Chaney (1948) states that there are no known Quaternary forest remains from Oregon except in the coastal region. In view of the lack of specific information on the critical areas, it seems wise not to emphasize the Wisconsin period or the Pleistocene generally as a time of strong isolation of sapsucker populations. However, it seems likely that these populations were no less isolated during the Wisconsin and perhaps the other glacial periods than they were in the Upper Pliocene or in Recent times.

During the Wisconsin period a population of the *daggetti-ruber* type or its immediate progenitors may have occupied the unglaciated coastal region of Oregon and Washington, an area which was largely separated from the interior by an ice cap covering most of the Cascade Range. Such a population would be a logical one to have developed into *ruber* by means which will be discussed subsequently, either during the Upper Pleistocene or even following it.

With the retreat of the ice sheet, great floristic and faunistic movements were gradually set in motion. The flora occurring in the eastern United States during the Pleistocene furnished most of the stock which eventually spread over southern and subarctic Canada east of the Rocky Mountains. With it came many essentially eastern birds, probably including *S. v. varius*. Western montane floras extended north along the Rocky Mountains and the Cascade and Coast ranges, and with them probably came, respectively, *S. v. nuchalis* and possibly *S. v. ruber*. Why *daggetti* or its progenitors, if present at this time, did not move north along the east slope of the Cascade Range, an area now occupied by *nuchalis,* is not clear. It may be that *nuchalis* or its ancestors retreated into this region from the southwest slope of the Rocky Mountains during the late Pleistocene and pushed back *daggetti* or its immediate ancestors. As the *daggetti*-like population was probably moving south itself, such a turn of events is not impossible; little more can be offered in support of this surmise.

It was mentioned that *ruber* may have been differentiated from *daggetti* or *daggetti*-like ancestors only since the Upper Pleistocene or even later. The reasons for this point of view are as follows. McCabe (1936) in a study of endemism in the American Northwest, pointed out that in the coastal region of British Columbia and southeast Alaska there are twenty-three endemic races and only one endemic species. McCabe hypothe-

sized that in view of the parallel variation in most of these forms—more saturated pigmentation and generally smaller size than their nearest relatives—the recent availability of their present range, and the fact only one form has attained specific status, that the British Columbia-southeast Alaska coastal endemics were relatively young forms that had developed *in situ* since the retreat of Wisconsin glaciation. He pointed out that there are a number of endemic species as well as races in what were unglaciated areas in Alaska and in the western United States. Were the endemic races of the northwest coast restricted to one group of birds, one might argue that a slow rate of differentiation in that group was responsible for the lack of endemic species in the area, but as parallel variation at the subspecies level occurs in the Pacific Northwest in several different avian orders such an objection does not hold. To the present writer McCabe's hypothesis appears to be sound.

S. v. ruber is not restricted to the British Columbia-southeast Alaska coastal region just discussed, but its range lies primarily within that area and a similar one immediately to the south. The saturated pigmentation of *ruber* also indicates a faunal affinity with the endemic races of the humid coast region. The fact that it is a large race of its species is in contrast to the generally small size of Pacific Northwest races, but it is not unmatched among them. For example, large, dark subspecies of the Song Sparrow are endemic to the northwest coast area. The possibility that *ruber* is an old form cannot be excluded, but if it is an old form, where was it before it occupied its present range, and why did it retreat from its former range? An obvious point is that *ruber* may have differentiated before the Pleistocene and that its present range has been repopulated by birds surviving in the unglaciated portions of Alaska. It is extremely doubtful, however, that *ruber* or any other race of *S. varius* ever occupied the Alaska refugium, for if any did there seems to be no reason why sapsuckers should be absent from that area today, when conditions are surely more favorable than during the Pleistocene. It is difficult to believe that an entire population has deserted one range for another, especially as environmental conditions must have improved in the former while the latter was becoming available. Also, as previously mentioned, *ruber,* although primarily a humid coast form, is at present a successful breeding bird in habitats other than the humid coast, and there is no apparent reason why it should not still occur farther south than it does today if it ever occurred there at all. There can be no question that its present range in British Columbia and southeast Alaska has been occupied since Wisconsin glaciation, and its extension of range into the summer-dry interior of British Columbia and even east of the Rocky Mountains denotes an expanding and not a retreating form. To the writer, the sum of the available evidence indicates strongly that *S. v. ruber* is a relatively young race that has developed in the Pacific Northwest at least since the start of Pleistocene time, either in the coastal area of Washington and Oregon or in southwestern British Columbia since the retreat of the Wisconsin ice sheet.

This development may have come about through the loss of migratory instinct in members of a partly isolated coastal population of *daggetti* or a closely similar form. A humid coast flora with forest elements similar to those found there today probably existed in the northwestern United States during Pleistocene time (Hansen, 1947:95), and the winters were probably mild enough to permit sapsuckers to occupy the region throughout the year. As outlined previously, a non-migratory race might attain partial reproductive isolation from a migratory one by establishing territories on the nesting grounds before the latter arrived on them. A failure to migrate probably would not be disadvantageous to sapsuckers in a relatively mild winter climate, and the non-migratory individuals, if first on their nesting territories in the spring, would tend to mate with one another and thus establish the sedentary characteristic in the population.

A sedentary population, partially isolated geographically and at the northern extremity of the range of an otherwise migratory form, would stand a good chance of being sufficiently isolated reproductively to develop into a distinct subspecies. In such a population there also would be a selective advantage for large size.

Since contacts between the breeding ranges of *S. v. varius* and *S. v. nuchalis*, *S. v. nuchalis* and *S. v. ruber*, and *S. v. varius* and *S. v. ruber* occur today largely in areas which were totally uninhabitable during the late Pleistocene, it is quite possible that these contacts have been secondarily established since the retreat of the Wisconsin ice sheet and thus within the past 10,000 years. Furthermore, it seems virtually certain that in British Columbia *S. v. ruber* has met *S. v. nuchalis* and *S. v. varius* since the last glacial period and has met them there for the first time.

The view adopted, then, includes the following stages: A monotypic but clinal population of *Sphyrapicus varius* occurring over much of North America by Lower Pliocene; the partial division of that population into eastern, Rocky Mountain, and Sierra-Cascade-Coast Range groups with the geographic, climatic, and resultant biological changes of Middle and Upper Pliocene; the possible further reduction of most of the contacts between these three partly isolated populations by Pleistocene glaciation, especially in the Wisconsin period; and, finally, the establishment of present-day contacts between the populations, by now differentiated into well-marked subspecies, after the retreat of the last great glacier. A fourth race (*ruber*) developed subsequently from an isolated population of one of the other three (*daggetti*).

It is not possible to say which of the present-day races is closest to the ancestral type, but it seems clear that any one of the modern subspecies could have been derived from any of the others through minor and cumulative genetic changes. The extreme forms have attained almost complete reproductive isolation although they may still interbreed in nature and produce fertile and viable offspring. However, it is not difficult to envision how the historical and biological factors such as those responsible for the differentiation of these races could proceed a step farther and complete the division of one species into two.

SUMMARY

The Yellow-bellied Sapsucker (*Sphyrapicus varius*) comprises four well marked subspecies, *varius*, *nuchalis*, *daggetti*, and *ruber*, which are considered by some to represent two species. *Varius* and *nuchalis* have a black, white, and red pattern on the head and breast and show sexual dimorphism in color. *Daggetti* and *ruber* have the head and breast all red, obliterating an underlying pattern similar to that of the other two races, and they show little or no sexual dimorphism in color. The red pigment is composed of carotenoids and the black is composed of melanins; probably these two pigment types are controlled by different genetic factors and are not modified by sex hormones even in *varius* and *nuchalis*.

In general, *varius* breeds in the eastern United States and Canada east of the Rocky Mountains; *nuchalis* breeds in the Rocky Mountains north of México and along the east slope of the Cascade Mountains; *daggetti* breeds in the Sierra Nevada; *ruber* breeds along the coast of the Pacific Northwest from Oregon to southeast Alaska and in central British Columbia.

Interbreeding between the races where their ranges meet is variable. It is apparently free between *ruber* and *daggetti*, moderate between *daggetti* and *nuchalis* and between *varius* and *nuchalis*, and rare or absent between *ruber* and *nuchalis* and between *ruber* and *varius*. The present investigation has attempted to find and evaluate some of the factors responsible for the complex relationships between these subspecies.

There seems to be no significant difference in the life histories of the four forms. Close study of nesting pairs involving birds of different and mixed racial stock reveals no evidence of lack of fertility or viability of intermediates. Isolating mechanisms consisting of geographic barriers and ecologic differences are thought to be of importance. Differences in homing and migratory tendencies and preferential mate selection on the basis of color may act to limit interbreeding.

Considered historically, the genus *Sphyrapicus* is probably derived from *Dendrocopos*, and the evolution of *S. varius* into races may have been initiated in response to orogenic and vegetational changes in North America in the Middle and Upper Pliocene, and may have been further influenced by Pleistocene glaciation. In all likelihood the action of factors of the same nature as those responsible for subspeciation could bring about further differentiation of *S. varius* into two full species.

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VARIATION IN THE RESIDENT SHARP-SHINNED HAWKS OF MEXICO

By ROBERT W. STORER

One of the most interesting parts of the large Milton S. Ray collection given to the Museum of Vertebrate Zoology of the University of California is a small series of Sharp-shinned Hawks (*Accipiter striatus*) collected by W. W. Brown in the Sierra Madre del Sur of Guerrero, México. This series includes an adult male, an immature female, and two immature birds which, although labelled "♀," are, on the basis of size, almost certainly males. The extremely pale coloration of the underparts of the adult in the Ray Collection and the confusion in the literature regarding the status of the breeding Sharp-shins of México made it appear desirable to borrow the available Mexican-taken specimens. Accordingly, I assembled the following: *Accipiter striatus*: Tamaulipas, 1 (Mus. Comp. Zool.); Nuevo León, the type and 4 topotypes of *A. striatus suttoni* (G. M. Sutton Coll.); Chihuahua, 3 (Mus. Comp. Zool.), 1 (U. S. Natl. Mus.); Sonora, 2 (Dickey Coll.); San Luis Potosí, 5 (La. State Univ. Mus. Zool.); Michoacán, 1 (Chicago Nat. Hist. Mus.), 1 (Univ. Mich. Mus. Zool.), 1 (G. M. Sutton Coll.); Guerrero, 4 (Mus. Vert. Zool.), 1 (La. State Univ. Mus. Zool.). *Accipiter erythronemius chionogaster*: Guatemala, 1 (Mus. Comp. Zool.); Honduras, 8 (Mus. Comp. Zool.). To Dr. Sutton and the curators of the collections mentioned, I am deeply indebted for making possible the gathering of this material, for, small though this series is, it is by far the largest group of these hawks yet assembled.

In addition, I examined and measured five examples of Mexican Sharp-shinned Hawks at the American Museum of Natural History. These specimens came from Chihuahua (1), Jalisco (3), and "Barbicom Ranch," state unspecified (1). Through the courtesy of Dr. J. T. Zimmer, I was also able to examine specimens of typical *striatus* and of *fringilloides, chionogaster, ventralis,* and *erythronemius* in the American Museum.

Size.—In the original description of *Accipiter striatus suttoni,* van Rossem stated (1939:127) "Size apparently slightly larger than *velox*: wings of four males, 178-188 mm." Table 1 shows the extremes and means of wing and tail measurements of Sharp-shinned Hawks from southern Arizona to Guerrero compared with a series from Michigan. The latter series consisted of 40 birds, largely taken during the migration and divided equally between males and females and between birds in first-year and adult plumages. As there appeared to be no significant difference between the measurements of adult and first-year birds in the Michigan series, the age groups of both populations were combined to obtain the means presented in the table.

Table 1

Wing and Tail Measurements of Sharp-shinned Hawks from Michigan and Southern Arizona and Mexico

	Michigan			Southern Arizona and Mexico		
	Number	Extremes	Mean	Number	Extremes	Mean
Wing length (arc)						
Males	20	161–178	168.8	19	170–192	181.9
Females	20	191–206	200.6	9	216–229	222.4
Tail length						
Males	20	130–139	134.6	20	131–150	139.6
Females	20	149–162	156.5	9	165–177	169.3

A comparison of the measurements of the Michigan series with those given by Friedmann (1950:185) for a series of specimens from throughout the range of *A. s. velox* shows that the Michigan series is somewhat smaller. Next to the *Buteo jamaicensis* com-

plex, *Accipiter striatus* is perhaps the North American hawk most in need of a thorough revisionary study, but it is doubtful that sufficient breeding material is at present available for such a study. Until a statistical analysis of size variation in the Sharp-shinned Hawk is made, it can only be stated that the birds of the Mexican populations average larger than those of the adjacent races.

The small size of the sample of Mexican birds prevents a statistical analysis of size variation within it. However, by inspection, it appears that there is little or no significant size variation among the various Mexican populations.

It is odd that the Mexican birds should be larger than the more northern populations. One might expect the reverse to be true, not only because of Bergmann's "rule," but perhaps even more because of the migratory habit of the northern birds as contrasted with the resident status of the Mexican birds. The situation is further complicated by the related form, *chionogaster*, which ranges from northwestern Chiapas (Edwards, MS) to El Salvador and which is small; wing length (arc): 3 males, 166–175 mm. (mean, 169.7), 6 females, 198–209 (203.1); tail length: 3 males, 130–135 (132), 6 females, 156–164 (160.1). Since these data show that there is apparently no correlation between size and latitude or between size and the migratory habit, it is necessary to cast about for another explanation. It seems to me that the answer may lie in the size of the prey available and in competition with other hawks with similar feeding habits.

Raptors are near the top of the pyramid of numbers; hence, the size of a hawk population is directly dependent upon that of the species upon which it preys. A sexual difference in size in raptors has a selective advantage in permitting the existence of a denser population by increasing the size range and hence the available numbers of the prey. In parts of North America there exists a graded series of accipiters ranging from the male Sharp-shinned Hawk through the female Sharp-shin and the male Cooper Hawk to the female Cooper Hawk. These birds, occupying in part the same range, can live side by side and can take prey of a wide variety of sizes without serious competition. However, if the sexual differences in size did not exist in the genus *Accipiter*, I seriously doubt whether four species, corresponding in size to the four size groups characterized by the two sex groups of the Cooper and Sharp-shinned hawks could exist together in the same area. In the first place, there would probably be too much overlap in size of prey utilized by the various species, and secondly, the total population of each species would have to be roughly half of that of the Cooper or Sharp-shinned hawks which could exist in the same area.

The breeding range of the Mexican Sharp-shinned Hawk, *A. s. suttoni*, appears to coincide with the pine-oak belt, which possesses a characteristic avifauna and one which differs considerably from that of the breeding grounds of *A. s. velox*. Hence, it seems to me likely that the differences in size between *velox* and *suttoni* reflect overall differences in the size composition of the groups of birds available to them as prey during the breeding season. And, furthermore, although the difference in size between these two races is small, this difference would, if anything, be advantageous in lessening competition during the winter when *velox* invades the range of *suttoni*.

Color and markings.—From the northeastern extreme of its range south as far as Guerrero there appears to be no significant geographic variation in the color of the upperparts of the Sharp-shinned Hawks. Specimens of the race *perobscurus* from the Queen Charlotte Islands, however, average darker dorsally; and the form *chionogaster* of Central America is considerably darker, almost black, above.

Friedmann (1950:202) states that the tail of *chionogaster* is "crossed by five broad bands (distinctly broader than the paler interspaces)" and uses this as a key character

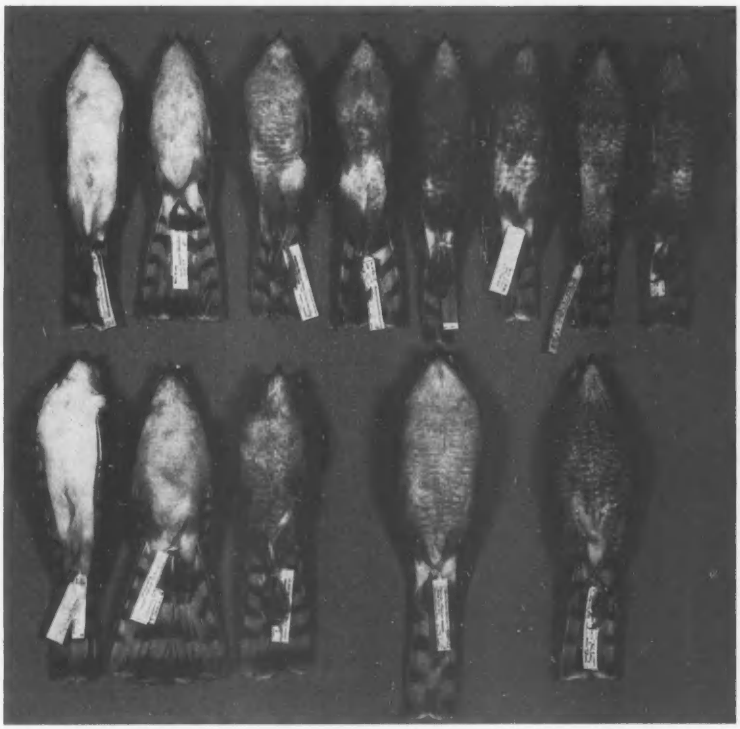

Fig. 1. Adults of *Accipiter striatus*. Top row, males; left to right: MCZ 145651, *A. s. chionogaster*, Finca La Primavera, Guatemala; MVZ 109341, *A. s. madrensis* (type), Cuapongo, Guerrero; LSU 10741, *A. striatus suttoni*, Llano de Coneja, San Luis Potosí; MCZ 48418, *A. striatus suttoni*, Galindo, Tamaulipas; GMS 7902, *A. striatus suttoni* (type), Mesa de Chipinque, Nuevo León; UMMZ 75150, *A. striatus* near *suttoni*, Huachuca Mountains, Arizona; UMMZ 59195, *A. s. velox*, Sand Point, Michigan; UMMZ 121529, *A. s. perobscurus*, Comox, Vancouver Island.

Bottom row, females; left to right: MCZ 169835, *A. s. chionogaster*, Cerro Cantoral, Honduras; LSU 14217, *A. s. madrensis*, Omilteme, Guerrero, México; LSU 10738, *A. striatus suttoni*; Llano de Coneja, San Luis Potosí; GMS 9679, *A. striatus suttoni* (topotype), Mesa de Chipinque, Nuevo León; UMMZ 114507, *A. s. velox*, Washtenaw County, Michigan.

for separating this form from *striatus* and its close relatives. Of the nine specimens of *chionogaster* which I have examined, three might be said to agree with Friedmann's description of the tail bars, five have the dark and light bars of nearly equal width, and one has the dark bars slightly narrower than the light ones. On the other hand, occasional examples of *velox* and *suttoni* have the dark and light tail bars approximately equal in width. It should also be noted that on the outer rectrices of all these forms the dark bars are much narrower than the light interspaces. Thus it will be seen that the character of the tail bars which is said to separate *chionogaster* from *velox* and *suttoni* is an average one and is not absolute as has heretofore been thought.

It is in the color and pattern of the underparts that the greatest amount of variation

is evident. Within a given population of *A. s. velox,* adults show a large amount of individual variation in the amount and intensity of rufous on the underparts. A thorough analysis of extensive series of specimens of breeding birds may prove that there is also a small amount of geographic variation in this character. On the other hand, the available material of Mexican Sharp-shinned Hawks indicates that in these birds there is considerable variation from one population to the next but relatively little variation within single populations. This is perhaps to be expected, since many of the breeding populations of these birds in México are small and discontinuous, and it is not illogical to assume that the color of the underparts is of less adaptive significance than size. In the birds from Tamaulipas and Nuevo León there is a considerable degree of sexual difference, the three adult males being darker and more solidly rufous below than the three females. This is well shown in figure 1. The three adult males and the one adult female from San Luis Potosí show little variation among themselves. All resemble the females from Nuevo León; and the males are, if anything, lighter than the female. The two adults from Guerrero have the breast and abdomen lightly washed with rufous and some of the feathers, especially those of the center of the abdomen, are faintly barred with pale rufous and white. The sides are more strongly washed with rufous. As in specimens of *velox* and *chionogaster,* skins of birds of the Mexican populations all have blackish shaft streaks on the throat and upper breast (more pronounced in the females), and the males are bluer above than the females.

In their first winter plumage, birds of the Mexican populations show a tendency to have paler and redder streaking on the underparts and more of a buffy wash on the whitish ground color. In these characters, however, they are matched by occasional individuals of *A. s. velox.* The immatures of *chionogaster* differ markedly from those of all of the more northern forms in being much more lightly streaked below (see figure 2).

The character by which specimens of the Mexican populations can best be separated from those of *velox* is the immaculate light rufous "flag" or shank feathers, which may or may not be narrowly tipped with whitish. This character appears valid for both adults and first-year birds. In specimens of *chionogaster,* the flags are washed with a very pale rufous and are unmarked. Adult Sharp-shins from southern Arizona tend to have two or three bars on some of the feathers of the flags and thus are intermediate between *suttoni* and *velox.* An adult female taken on March 21, 1948, 15 miles west of Quiroga, Michoacán, and an adult male taken on December 29, 1929, at Tesia, Sonora, also appear to be intergrades and may both be birds taken away from the breeding grounds. Two immatures taken in July, 1888, at Bravo, Chihuahua, and a third taken in July, 1905, at "Pachaco," Chihuahua, are all indistinguishable from *velox,* as is an immature female taken at Tesia, Sonora, on March 23, 1930. I have referred these to *velox* tentatively, although it is possible that in the region of intergradation between *velox* and *suttoni,* the young may resemble the former and the adults, the latter race.

Because of the scarcity of specimens of *A. striatus suttoni* in museums, a comparison of the type with the color plate of it which appeared with the original description (van Rossem, *1939:127-128*) is desirable. The type specimen is much blacker above, especially on the head, than shows in the plate. The underparts are a colder cinnamon with much less yellow, and there are conspicuous, though fine, black shaft streaks on the feathers of the throat and upper breast. In the original painting, the eye color is noticeably less orange and more brown than it appears in the reproduction.

There appears to be considerable geographic variation in the color of the iris of adult Mexican Sharp-shins. The type and four topotypes of *suttoni* from Nuevo León had brown or brownish eyes. (Two adult males, iris "dark brown" and one, "dark brown

with faint reddish cast;" one adult female, iris "dark brown with reddish cast" and one, "dark brownish red.") Three adult males from San Luis Potosí had irides which were "ruby red" (2) or "reddish." Rather surprisingly, an adult male (labelled "♀" A.M.N.H. 105,303) from the Volcán de Nieve (= Nevada de Colima), Jalisco, has the "eyes, sulphur;" and the five birds from Guerrero, two adults and three first-year birds, are

Fig. 2. Immatures of *Accipiter striatus*. Top row, males; left to right; MCZ 158083, *A. s. chionogaster*, El Derrumbo, Honduras (probably missexed); MVZ 109340, *A. s. madrensis*, Cuapongo, Guerrero (labelled "♀"); MVZ 109342, *A. s. madrensis*, Cuapongo, Guerrero (labelled "♀"); LSU 14904, *A. striatus suttoni*, mt. just SE of Cañada Granada, San Luis Potosí; UMMZ 70980, *A. s. velox*, Muskegon County, Michigan; UMMZ 62426, *A. s. perobscurus*, Tillamook, Oregon.

Bottom row, females; left to right: MCZ 169836, A. s. chionogaster, La Laguna Cantoral, Honduras; *MVZ 109343, A. s. madrensis*, Chilpancingo, Guerrero; UMMZ 121548, *A. s. velox*, 1 mi. W Dexter, Michigan; UMMZ 62421, *A. s. perobscurus*, Cedar Hill, Vancouver Island.

all labelled as having "yellow" irides. Again, the irides of adult specimens of *chionogaster* have been variously described as "blood-red" for the male (Dickey and van Rossem, 1938:109; Friedmann, 1950:202) or "orange" for the female and "dark brown, like burnt sienna" for the male (Kaup, 1851:41).

The rather striking variation from one population to another in the colors of the underparts and of the irides contrasts sharply with the apparent lack of variation in

other characters within these groups. Quite possibly, these color characters are non-adaptive and hence subject to rapid change through the random fixation of different variations in the small isolated populations. On the other hand, size in predatory animals is an adaptive character; hence individuals of the same species living in areas which are similar as regards the available prey species and competing predators are probably subject to the same selective pressures in the control of their size.

Conclusions.—The distinctness of the Guerrero population warrants its description, and I hereby propose to call it

Accipiter striatus madrensis, new subspecies

Type.—No. 109341, Mus. Vert. Zool., adult male, taken at Cuapongo, Guerrero, Mexico, June 9, 1938, by W. W. Brown.

Diagnosis.—Adults similar to *Accipiter striatus suttoni* van Rossem, but much paler below. Underparts whitish, washed and faintly marked with pale rufous. Feathers of the sides and tibiae light rufous, unmarked. According to the collector, the iris is yellow. The first-year birds may have on the average paler streaks on the underparts than the young of *suttoni* (see figure 2), but even the limited material available indicates that there is considerable overlap between these two races in this character.

Range.—Known only from the Sierra Madre del Sur of Guerrero (specimens recorded from Chilpancingo, Cuapongo, and Omilteme); however, on geographic grounds, it might be expected to occur in Oaxaca west of the Isthmus of Tehuantepec.

A. striatus suttoni is found as a breeding bird in suitable areas throughout México north of the Rio Balsas and excluding Baja California. Birds from southern Arizona and New Mexico and from Chihuahua and Sonora appear to be intergrades with *velox.* To the south, *suttoni* may intergrade with *madrensis,* but the only evidence of this is the yellow-eyed adult male from the Nevada de Colima, Jalisco. In the color of the underparts, however, this bird is close to topotypical material of *suttoni* and must be referred to that race. Intergrades might be expected to occur in the Sierra de Coalcomán in Michoacán, but I failed to find the species in my brief stay there in 1950. In addition to the specimens which I have examined, specimens of *suttoni* have been recorded from Coahuila and Veracruz by Friedmann, Griscom, and Moore (1950:42).

According to van Rossem (1939:128), Lesson described *Nisus pacificus* from the "area from Acapulco, Guerrero, Mexico, to California." Since van Rossem states further that "*pacificus* . . . relates to a bird definitely banded on the 'breast, sides and belly,'" this name must apply the North American form *velox,* which is not rare in the lowlands near Acapulco in winter. To date, we have no evidence that *madrensis* ever leaves its montane habitat.

The form *chionogaster* is the southern representative of the continental North American forms of *Accipiter striatus* (*perobscurus, velox, suttoni,* and *madrensis*), and its breeding range is separated from that of *madrensis,* the southernmost of these races, by the Isthmus of Tehuantepec. In the color of the upperparts and in the pale streaking of the young, *chionogaster* is distinct from the North American forms. In the relative widths of the tail bars and in size, it intergrades with these forms. Although there is as yet no evidence of gene flow in the opposite direction, the paleness of the underparts of *madrensis* suggests that there has been an influx of genes from *chionogaster* into that population. In the light of this evidence, it seems best to consider *chionogaster* conspecific with *striatus,* and since *chionogaster* has been considered conspecific with the South American forms, *erythronemius, salvini,* and *ventralis,* these also become subspecies of *striatus.* Therefore, I propose that the forms of *Accipiter striatus* stand as follows:

Accipiter striatus perobscurus Snyder
Accipiter striatus velox (Wilson)

Accipiter striatus suttoni van Rossem
Accipiter striatus madrensis Storer
Accipiter striatus chionogaster Kaup
Accipiter striatus salvini (Ridgway)[1]
Accipiter striatus ventralis Sclater
Accipiter striatus erythronemius Kaup
Accipiter striatus striatus Vieillot
Accipiter striatus fringilloides Vigors
Accipiter striatus venator Wetmore

[1] I am not prepared to discuss the validity of *salvini*, which has been accepted by Peters (1931:221) but synonomized with *ventralis* by Hellmayr and Conover (1949:75-77). In making the above arrangement, I have departed from the usual placement of the West Indian forms (*striatus, fringilloides,* and *venator*) between *suttoni* and *chionogaster* for two reasons: *madrensis* forms a natural link between these two forms; and since the West Indian forms resemble *erythronemius* in the barring of their underparts, it is possible that they may be more closely related to the South American forms than to those of North America.

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University of Michigan Museum of Zoology, Ann Arbor, Michigan, March 13, 1952.

NESTING OF THE HUDSONIAN GODWIT AT CHURCHILL, MANITOBA

By RUSSELL T. CONGDON

Before going to Churchill, Manitoba, in 1950, we had been told of the possibility of finding the rare Hudsonian Godwit (*Limosa haemastica*). We saw none that year but were more fortunate in 1951. While exploring the wide expanse of tundra a few miles out of Churchill, we saw four dark-colored shorebirds nearly as large as Hudsonian Curlews. Their bills were slightly upturned, their underbodies were brownish red, and when one of the birds took wing, the white rump patch and white wing markings were clearly visible; Hudsonian Godwits!

We made several trips out to the area hoping to find a nest. Then, on July 15 a pair of the godwits appeared and flew about, acting so disturbed that we thought they must

Fig. 1. Adult Hudsonian Godwit near nest at Churchill, Manitoba.

have a nest. After a long search, I caught sight of some pieces of broken eggshell in the marsh grass. Looking closely, I discovered a downy young on the edge of the nest and a few feet away another youngster. The nest was a little depression on a slightly raised hummock in a wet bog. We carried the two chicks to a raised patch of tundra close by, where we could kneel down and hold them, hoping to coax the parent godwits close enough for a photograph. The parents were greatly excited and when we settled down on the tundra they flew about and alighted near us. One parent came up within twenty feet, calling to the peeping youngsters (fig. 1). After photographing the adults we returned the young to their nest and pictured them (fig. 2). They were colorful chicks with

Fig. 2. Recently hatched young of Hudsonian Godwit at the nest.

buff, gray, and darker mottling on the back and wings and with golden brown predominating on the sides and underparts.

As far as known, only one other nest of this godwit has been found in recent years. That was in 1947 as reported by Hazel R. Ellis (Audubon Mag., 50, 1948:154-159).

Wenatchee, Washington, April 28, 1952.

NESTING BEHAVIOR OF THE SOUTHERN HOUSE WREN IN SURINAM

By FR. HAVERSCHMIDT

The range of the Southern House Wren (*Troglodytes musculus*) is very large, as the species occurs from the tropical coastal zone of eastern México and the Lesser Antilles southward to Argentina, Chile, and the Falkland Islands. In Surinam the bird is well known as the Gado fowroe (God bird). It is one of the commonest birds in the cultivated area of the coastal region and is present everywhere in gardens of the town and smaller settlements. This wren is also found in the extensive "parwa," the woods of *Avicennia nitida* bordering the sea coast, in the coffee plantations, and on the dry sandy savannas in the interior of the country. It is lacking, however, in the midst of dense forests, but an abandoned shed in a clearing will almost certainly harbor a couple of these birds.

This house wren is somewhat larger than the European Wren (*Troglodytes troglodytes*). The weight of two males was 12.2 and 12.6 grams, of two females 11.7 and 13.4 grams. The sexes are indistinguishable in appearance, but only the male sings.

Display.—The display seen most commonly is one in which both members of a pair vibrate their wings like begging nestlings, the male singing loudly, the female uttering a chirupping sound. This display was seen when there were nestlings seven days old in the nest belonging to the displaying couple.

A few times I observed another kind of display which may be considered as a threatening display. On March 24, 1946, two wrens were seen together, one of them singing and drooping its wings. It kept its head and bill turned upward, the other bird sitting near by but taking no notice whatever of the displaying bird and keeping silent. Both birds moved through the shrubbery, keeping each other's company, the male singing continuously and displaying in the manner described. It looked as if it was showing its white throat and breast to the other bird.

On May 30, 1946, two birds were fighting and chasing each other while a third one remained on the spot and sang all the time with its head and bill pointed upward in a stiff way and the wings trembling. Again on June 16, 1946, three wrens were chasing each other, two of them singing and trembling the wings, but this time the pointing upward of the head and bill was not seen.

Courtship feeding was never seen, although in the common display in which both sexes sit with trembling wings near each other, the male singing and female uttering a chirupping sound, I often expected it. It is indeed apparently absent in the Troglodytidae (Lack, Auk, 57, 1940:169-178).

Breeding season.—Nests with eggs may be found in all months of the year. In the large oological collection assembled in Surinam for the Penard brothers, there are sets of eggs for every month of the year. However, most sets were taken in January and July (Hellebrekers, Zool. Medeelingen, 24, 1942:274).

Certainly at least two broods are reared in a season; presumably even more are raised but this can only be ascertained with certainty by color marking of individual birds. A pair in my garden reared two broods in the same nest. On December 24, 1948, the nest contained four eggs and the young left on January 23 and 24, 1949. On February 10, 1949, the nest seemed to be lined again with white feathers, but the second brood was not started until April. On April 25 there were four eggs. The interval between the first and second broods was therefore 92 days.

Nest building.—This wren is not conservative in its choice of a place to build its

nest. In the town and in settlements the nest is very often found on rafters under houses, but also in sheds, in all kinds of crevices, and in holes of trees.

The nest itself is an open one and a rather rough affair of dry sticks of different lengths protruding in all directions, with a nest cup in the middle of it. The cup is lined with soft material, such as feathers, but I have also found pieces of soft paper and even a wing of a cockroach.

Both sexes take part in the building of the nest, a fact which can be ascertained easily as the male often sings when coming to the nest with a stick in its bill. Many nests which are started are never completed. The building itself goes on in a rather leisurely way, and a long time may elapse before the nest is ready for eggs. On December 1, 1948, I found a nest which was not yet lined with feathers; the first egg was not laid until December 25.

When the same nest is used again for the second brood, it is probably cleaned. On May 18, 1947, I watched a female wren (the male was singing near by) taking feathers from a nest to let them drop at some distance. It returned to the nest about a dozen times, each time taking a white feather from the nestcup. On June 29 this nest contained a clutch of three eggs.

Clutch size.—In the Penard oological collection, the majority of sets of this wren consist of three and four eggs. As to the measurements of the eggs I refer the reader to the paper by Hellebrekers (1942, *op. cit.*). The weights of three fresh eggs (April 24, 1949) were 1.68, 1.78 and 1.92 grams.

Incubation.—Incubation is performed by only one bird and in all cases the non-singing one, that is, the female. Only once could I establish the incubation period. The last egg of a clutch of four was laid on April 29, 1949. On May 12 at 12:30 a.m., one nestling hatched, following by two others at 3:45 p.m. The last one was out of the shell in the early morning of May 13. This gives an incubation period of 14 days. Skutch (Auk, 62, 1945:22) reported incubation periods of 15 and 16 days for *T. m. inquietus* in Panamá and 16 and 17 days for *T. m. intermedius* in Costa Rica.

The rearing of the young.—The second brood hatched at my house in May, 1949, permitted observations on the rearing of the young. The nest could be watched easily from behind a shutter. In table 1 data on development of the four nestlings are given

Table 1

Daily Weights of Nestlings in Grams

	Nestling			
Age in days	1	2	3	4
0	2.50	1.95	1.90	2.05
1	2.93	2.75	2.20	2.70
2	4.25	3.92	3.38	3.72
3	5.28	5.24	4.55	5.52
4	7.16	6.95	6.20	6.82
5	9.32	8.72	7.80	8.32
6	10.52	9.95	9.07	9.95
7	11.65	10.95	10.45	11.32
8	12.72	11.92	11.52	12.82
9	13.07	12.70	12.60	13.12
10	14.00	13.27	13.22	12.85
11	13.78	13.65	13.15	12.50
12	13.50	13.10	13.00	12.93
13	13.33	13.33	13.08	.....

until the 13th day. After that time I refrained from weighing them as they might have left the nest prematurely. The young were covered by the adult bird until May 16, the age of the young then being four days.

Both sexes fed the young in the nest, the male being easily recognized, as it often arrived singing with food in its bill, to leave singing again after delivering it. Often the male came with food while the female was still on the nest and then the female sometimes took the food from the male's bill to deliver it herself to the nestlings. It became clear, and I noticed no exception of this rule, that at each feeding visit all the food was given to only a single nestling.

The feces of the young were swallowed by the old birds until the nestlings were three days old and from then on they were taken away. When the young were able to stand in the nest, it was seen that a nestling about to defecate stood up with drooping wings and deliberately turned its abdomen upward to the adult bird. The latter took the fecal sac as soon as it emerged from the cloaca of the nestling.

When watching the feeding of the young, I observed another typical postfeeding behavior consisting of "probing" or "digging" among the nestlings after the food had been delivered to a single nestling. On doing this the old bird dived head first amidst the nestlings, wriggling with its wings, doing its utmost to reach something which remained invisible to me. Whatever was sought apparently lay on the very bottom of the nest, as the bird was almost standing on its head. When emerging again, the parent made distinct swallowing movements.

This postfeeding behavior was first described by Pullen (Brit. Birds, 38, 1945:206). Afterward an interesting discussion followed in the journal "British Birds" from which it became clear that this behavior is of common occurrence in a number of small passerine birds. Of the suggestions given in this discussion, I would support the theory that parasites are removed and eaten. I would add the idea that removal and swallowing of remnants of food just delivered to a nestling also occurs, for I often saw distinctly that the particular nestling which got all the food had difficulties in swallowing the whole lot. I must admit, however, that I never was able to discern what the old bird was actually eating after the probing. I agree with Hurrell (Brit. Birds, 38, 1945:300) that the action has nothing to do with the ordinary removal of feces. This conclusion is supported by the following observation: On May 22 at 3:52 p.m., when the young were 10 days old, an adult bird was in the act of probing among the nestlings in the matter described when it was interrupted by the defecating of one of the nestlings. The parent stopped probing immediately and, to my surprise, took the fecal sac and swallowed it, then started probing once more. When it emerged again, it was seen swallowing something.

As pointed out before the fecal sac was normally taken away from young of this age and my explanation of this exception from the rule is that the bird was suddenly interrupted in its postfeeding action of probing and that it simply could not fly away at this stage and so swallowed the feces.

In table 2 I give a list of the frequency of feeding, probing and fecal removal in one-hour periods. I was able to establish the fledging period of the young in two instances. The first brood at my house hatched on January 5, 1949, and left the nest on January 23 and 24, which gives a fledging period of 18 to 19 days. The second brood in the same nest hatched on May 12 and 13 and left the nest on May 29, which gives a fledging period of 17 to 18 days. These figures agree with those provided by Skutch (1945:22). After leaving the nest the young are fed for some time by both parents.

I marked the young of the second brood which left the nest on May 29 and so was able to recognize them. Although two of them fell victim to a cat shortly after leaving

Table 2

Frequency of Feeding, Probing and Fecal Removal in One-hour Periods

Date	Age of young in days	Time	Times fed	Probing	Fecal removal
May 17	5	2:50 p.m.–3:50 p.m.	17	5	4
May 20	8	3:15 p.m.–4:15 p.m.	11	1	4
May 22	10	9:55 a.m.–10:55 a.m.	21	8	6
		3:12 p.m.–4:12 p.m.	12	6	3
May 25	13	2:58 p.m.–3:58 p.m.	13	1	3
May 26	14	2:57 p.m.–3:57 p.m.	16	3	4

the nest, the other two were still being fed by one of the old birds in my garden on June 5, which is seven days after fledging. I did not see them afterward, so I am not able to say whether this period of dependency on the old birds is not longer.

Parasitism by cowbirds.—In Surinam the Southern House When is a common host of the Shiny Cowbird (*Molothrus bonariensis*) as reported by the Penard brothers (De vogels van Guyana, 2). I watched a female cowbird inspecting the rafters of a building where wrens were nesting regularly on March 7, 1947, and August 16, 1950, the wrens being present and scolding loudly. When the cowbird left, it was pursued in flight by one of the wrens.

Paramaribo, Surinam, South America, March 17, 1952.

THE AVIFAUNA OF THE BARSTOW MIOCENE OF CALIFORNIA

By LOYE MILLER

For more than forty years the Upper Miocene beds known as the Barstow Syncline have been under the scrutiny of vertebrate paleontologists representing widely separated institutions and having greatly divergent backgrounds. An extended account of this area in the Mohave Desert of California was published by Merriam (1919). Here he discussed the general geology and paleontology and correlated the faunas as far as known up to that time. Very little had been recovered except mammal remains. One reptile was described (*Testudo mohavense*) and three fragments of bird bone were recorded as buteonid hawks. In succeeding years there has been a good deal of work done on the mammal fauna but very little has been added to the record of birds (L. Miller, 1950).

During the past three years, some painstaking and enthusiastic surface collecting has been done in the Barstow Syncline by Messrs. Richard Tedford and Robert Shultz with the result that an interesting, though small, collection of bird remains has been assembled. Some of this material is located at the Los Angeles Museum (L. A. Mus.) and some at the University of California at Los Angeles (UCLA). All of it has been made available for this study along with field notes and personal comment by Tedford and Shultz.

The material is so highly fragmentary that specific identity has in most instances not been determined. However, the familial relationships displayed are of great significance in reconstructing the ecologic picture of the area during Upper Miocene time. Specimens are beautifully mineralized and have suffered very little corrosion or distortion from pressure. Fragmentation seems to be due to breaking up of the matrix by Recent surface erosion. Excavation below the weathered zone is not practicable because of the rarity and the widely separated locations of bird remains. It is a pleasure to acknowledge the services of Messrs. Tedford and Shultz in bringing this bird material to light.

RECORD OF SPECIMENS

CICONIIFORMES

Megapaloelodus connectens A. H. Miller

Four specimens: UCLA no. 2303.—Distal condyles of left tibiotarsus in excellent condition; this is the second example of the species and the first from the Upper Miocene. UCLA no. 2303A.—Distal end of right ulna in less perfect condition than the preceding. UCLA no. 2303B.—The distal end of a toe bone that probably came from the same individual as did the tibia and ulna. UCLA no. 2346.—Coracoid nearly complete.

The tibial condyles and the distal portion of the ulna of this species were described in a previous paper (L. Miller, 1950). The coracoid (UCLA no. 2346) was collected two years later from the same station where the others were taken. The characters of the bone and its size are so distinctly in harmony with other remains that I feel little doubt that all the specimens came originally from the same individual bird.

The coracoid resembles nothing else so much as it does the flamingos but still it is quite distinct from *Phoenicopterus*. Likewise it differs from *Paloelodus* of the Oligocene of France in its greater size and in the relatively longer shaft. Unfortunately both extremities of the sternal base are lost, which fact makes it difficult to express these differences in mathematical ratios. Reference to figure 1 is more enlightening. Measurements of the coracoid of *Megapaloelodus* follow:

Length, head to axial end of base	62.5 mm.	Depth, narrowest part of shaft	10.0 mm.
Length, head to center of scapular cup	27.0	Humeral facet	19.0 x 10.0
Width, narrowest part of shaft	10.5	Scapular cup	9.0 x 7.7

Comparison is here made with the corresponding bone from *Phoenicopterus antiquorum,* a specimen from captivity, unfortunately, but one that shows no pathologic abnormality. The coracoid of the fossil differs from that of the Recent bird in the following respects: (1) The head, distal to the glenoid facet, is narrower and more elongate. (2) The furcular facet is differently proportioned and its proximal border (brachial

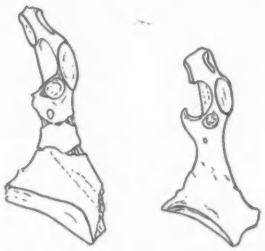

Fig. 1. Left, *Megapaloelodus connectens,* coracoid; UCLA no. 2346; Upper Miocene, Barstow Formation. Right, *Phoenicopterus antiquorum*; Recent, aviary specimen. Both ×½.

tuberosity) overhangs a deep pit which is lacking in *Phoenicopterus.* (3) The coracohumeral surface is longer and describes a much more open curve. (4) The scapular facet is a deeper and more sharply defined pit (this distinction is possibly accentuated by the fact that the Recent skeleton came from a captive bird). (5) The coracoidal foramen is larger and more elliptical in outline. (6) The shaft of the bone is more elongate; hence it appears to widen out less abruptly toward the sternal articulation. (7) The sternocoracoidal impression is marked by two practically continuous intermuscular ridges that are scarcely indicated in the flamingo.

This flamingo-like bird was assigned to a distinct genus and species by its describer (A. H. Miller, 1944) because of its divergence from *Paloelodus* of France which was considered to be its closest relative. The Old World specimens were collected from Oligocene strata which yielded fairly abundant material representing several species (Milne-Edwards, 1867-71). They were set off from true *Phoenicopterus* by a variety of characters which include a much less specialized beak. The Barstow specimen of *Megapaloelodus,* on the other hand, has a more specialized intratarsal articulation than either *Paloelodus* or *Phoenicopterus.* Assuming that the general characters of the North American bird are rightly interpreted, it seems to me that subfamilial distinction is strongly indicated. A. H. Miller suggests the same distinction after his study of the metatarsal trochleae. The following quotation from his original description is offered: "The characters of the metatarsus alone might lead one to erect a separate subfamily for *Paloelodus* and *Megapaloelodus* although other parts of the skeleton apparently do not support the action." This statement was based on the study of the trochleae alone. The tibial condyles of *Megapaloelodus* (L. Miller, 1950) show a degree of specialization of the intratarsal articulation that I have seen in no other group of birds. The European *Paloelodus* shows but the faintest indication of this specialization. Was it the incipient stage of a specialization that progressed through Oligocene and Lower Miocene to a

climax in the Upper Miocene of Barstow? Unfortunately the geologic record of intermediate stages has not been uncovered. The genera *Paloelodus* and *Phoenicopterus* were both found in the same Oligocene strata of France, but up to the present *Phoenicopterus* has not been reported from American formations older than Pliocene (L. Miller, 1944).

ANSERIFORMES

There are seven fragments in the assembled collections from Barstow that are recognizable as duck remains. Specimens are so fragmentary and the duck family is such a large and widely diversified group that it is not felt wise to assign these fossils to genus and species. Basic principles concerning distribution, both in time and in space, would be involved if names were suggested, and, once a statement gets into the literature, it may prove a stumbling block rather than a stepping stone. I prefer therefore to discuss the fragmentary material in broader taxonomic terms and to emphasize its ecologic significance only.

The following specimens are definitely assigned to the Anatidae:

L. A. Mus. no. V493.—Distal condyles of a left femur, quite badly fragmented but recognizable as a duck about the size of the Mallard (*Anas platyrhynchos*).

L. A. Mus. no. V493.—Head of right coracoid from a duck about the size of a female Green-winged Teal (*Anas carolinensis*).

L. A. Mus. no. V471.—Tibial condyles approximately the same as those of the Mallard (female).

L. A. Mus. no. V492.—Left coracoid almost complete from a duck about the size of a female Baldpate (*Mareca americana*) but with relatively shorter head and longer shaft. I have seen no Recent species with the same proportions.

L. A. Mus. no. V492.—Head of right coracoid about equal to that of the Ruddy Duck (*Oxyura jamaicensis*).

L. A. Mus. no. V498.—Distal condyles of the left humerus of a small duck.

L. A. Mus. no. V498.—Head of coracoid similar to that of the Ruddy Duck.

FALCONIFORMES

Three fragments of tibiae and tarsi representing buteonine hawks of two species were reported by Merriam (1919). I examined them at Merriam's request in 1915 and they were again examined by Dr. Hildegarde Howard thirty years later without change of classification. The specimens were not available for the present study. Presumably they were taken from the tufaceous matrix that comprises the main mass of the Barstow accumulation. There is an ungual phalanx (L. A. Mus. no. V498) which appears to be from a small species of *Buteo*.

GALLIFORMES

Cyrtonyx tedfordi new species

Type.—no. 42,223 Univ. Calif. Mus. Paleo., right carpometacarpus.

Diagnosis.—Very similar to the male of *Cyrtonyx montezumae mearnsi*, but much stouter and with intermetacarpal tubercle much less developed.

The first portion of this tiny bone was picked up in April of 1951. After a rain storm the site was revisited in the following July, when Tedford found the second fragment. In the laboratory the two surfaces of the fracture were found to intermesh perfectly. The result is a carpometacarpus almost exactly the size of the corresponding bone from a male Mearns or Massena Quail (*Cyrtonyx montezumae mearnsi*) from Arizona but it is heavier throughout and has the intermetacarpal tubercle represented by a very slightly developed though sharp-edged ridge instead of by a papilla. *Cyrtonyx* has this papilla much less strongly developed than does *Lophorytx*. In fact, this character as developed in *Cyrtonyx* shows a stage almost exactly intermediate between *Lophortyx* and the Barstow fossil.

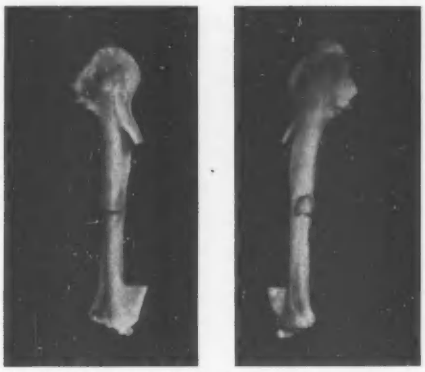

Fig. 2. *Cyrtonyx tedfordi*, carpometacarpus, anconal and palmar aspects, × 2; no. 42223 Univ. Calif. Mus. Paleo. Photo by Robert I. Bowman.

Colinus, Callipepla, Oreortyx, Dendrortyx, Rollulus, and *Arborophila* all have the tubercle strongly developed. *Crax* and *Penelope* have it represented only by a scar while other osteologic characters show these cracids to be far removed from the quails.

The Barstow specimen is much smaller than *Ortalis pollicaris* A. H. Miller, a chachalaca from the Lower Miocene of South Dakota, and it shows osteologic differences that separate it from that genus. The familial relations of the Barstow bird, except for the intermetacarpal tubercle, appear to lie with the American quails, but assignment to the genus *Cyrtonyx* is tentative.

The specific name is chosen in honor of the astute young paleontologist Richard Tedford.

CHARADRIIFORMES

The tibial condyles (UCLA no. 2346C) of a gull-like bird constitute the total material definitely assigned to this great order. The specimen corresponds in size fairly closely with the California Gull, *Larus californicus*. The present day California Gull frequents the inland lakes of the West. Was this an antecedent relative with comparable habit?

A single tiny ungual phalanx (UCLA no. D) is assigned with great reserve to the gull tribe. Along with the preceding tibial fragment, it came from the lacustrine lens that yielded the flamingo remains.

COLLECTING LOCALITIES

The avian remains here recorded were retrieved from a number of field localities that are fairly well distributed over the area known as the Barstow Syncline and they come also from several different levels in the vertical section. Tedford's notes give us the following information:

Specimens labeled V471 came from "Locality in south limb of the syncline entirely within a bed of pure white tuff some fifteen feet in thickness and of local extent. This locality is the '*Hemicyon* Stratum' of the Frick parties—extensive quarrying operations had been carried on here. The locality is approximately in the SE ¼, SW ¼, Sec. 14, T11N, R2w, MDB&M. Searles Lake Quadrangle of U.S.G.S." The tibial condyles of a Mallard-sized duck were taken here.

V492. Lake Bed Horizon (Also UCLA 2303 & 2346). "Tuffaceous clays varying between 1 and 3 ft. in thickness; calcareous lenses in its lower ⅔; resting on 3 ft. of compact white sandstone which is in turn underlain by fossiliferous brown tuffs of the usual character and the whole is overlain by fossiliferous brown tuffs of similar composition. Mollusks found along the extent of the beds which is lens-like in appearance. South limb of syncline approximately ½ mile west of V471; approximately

300 ft. below V471 in the middle of SE ¼, NW ¼, Sec. 15, T11N, R2w." This locality has yielded the majority of the bird remains known from the Barstow. They include a flamingo, several ducks, a hawk, and a quail. The physical evidence of lake bed type of deposition is here most definitely recognizable.

V493. "Thick and abundantly fossiliferous bed of brown tuff and fine sandstones approximately ⅛ mile east of V492 and extending along about ⅛ mile of exposure. South limb of syncline approximately 20 ft. below V492 in SW ¼, NE ¼, Sec. 15, T11N, R2w." The very fragmentary material from this locality represents two species of ducks, one about the size of the Recent Mallard and the other one comparable to the Green-winged Teal. A premolar of a three-toed horse, *Merychippus,* a rabbit tooth, and the toe bone of a cat-like animal were associated.

V498. "Beds of fine orange brown tuff exposed in the upper reaches of the first large wash from the south opening to the west. South limb of the syncline approximately ¾ mile southeast of V493 and stratigraphically about 100 ft. above it. Approximately in N ½, SW ¼, Sec. 14, T11N, R2w." Two small duck bones and the claw of a buteonid hawk were taken here.

Tedford also comments on the much more abundant mammal fauna as follows: "We could not find any difference in the total aspect of the fauna from top to bottom of the fossiliferous tuff—the fauna viewed as a whole is homogeneous, the slight differences present being differences in facies." There is furthermore no reason to feel that other than Upper Miocene is represented.

DISCUSSION

Merriam's study of the mammal faunas (1919) pictured in his mind "an open country . . . affording fairly abundant grass and herbage, and evidently better watered than the Mohave Desert of the present day. The abundant remains of grazing horses of the *Merychippus* type, the presence of mastodonts, oreodonts, and merycodonts, a considerable variety of camels and a peccary all indicate that nutritious vegetation must have been more abundant than at present." He mentions *Planorbis, Limnaea* and *Anodonta* in his tabulation of faunas but does not designate the exact locality from which they came. His only comment is that "the section in the Barstow Syncline consists in large part of volcanic materials with beds of clay and shale at some horizons. The deposits are evidently partly of terrestrial and partly of lacustrine origin. At rare horizons, remains of fresh water mollusca . . . are abundant. In other beds, scattered and weathered bones representing a large tortoise and numerous mammals belonging to the open plains type probably indicate accumulation on dry land." Tedford and Shultz evidently worked one of these lenses when they uncovered the aberrant flamingo. In recording this bird from California (L. Miller, 1950) it was stated that the area apparently consisted of "a small shallow and ephemeral body of water in which sedimentation took place, for the lens is thin and it diminishes gradually to its margins. It is overlain by the same type of rock as that upon which it rests. Whether or not its waters were entirely fresh is not known but careful search revealed no significant deposits of gypsum, borax, or soluble salts. The presence of calcareous layers interbedded with clays would, however, suggest cycles of time greater than annual cycles, during which the lake waters were highly concentrated . . . . It is possible, therefore, that the Miocene lake may have contained salts not preserved to us in Recent time. On the other hand, Merriam postulates a more abundant rainfall than is normal in Barstow today. In the Lower Pliocene beds (Ricardo) to the westward there occur the petrified stems of palms and broad-leaved trees (*Robinia*). Furthermore, imprints of palm leaves were found in the Barstow by Tedford and Shultz. Quite certainly the present mountain barrier which cuts off the moisture laden sea winds from the south coastal area, was either much lower or even nonexistent . . . . Still there is no assurance that there did not occur at times the bitter lake environment that seems to attract the modern flamingos."

A survey of the avifauna as a whole gives a definite impression of lacustrine influence not only in localities where lakes were of sufficient permanence to develop an aquatic

molluscan fauna but in some which showed no such evidence either in molluscan species or in lithologic characters.

Rainwater ponds of short duration in the southwest country at the present day prove attractive to migrating or winter-drifting gulls, ducks, and wading birds. Such ponds seem to have been quite widely scattered both in space and in time during the accumulation of the Barstow beds. The suggestion is of rainwater ponds of a mesa land rather than true lakelets of a drainage system. In those cases where they were sufficiently lasting to accumulate aquatic molluscs and a measure of lacustrine sediments, they may have been parts of local drainage systems but the suggestion to the present writer is of a mild topography without pronounced stream action though with fairly abundant rainfall at certain seasons. It supported an open-country vegetation with ephemeral pools that offered loafing grounds to a shifting population of aquatic birds. Only occasionally were the ponds of sufficient duration to harbor mollusks and attract flamingo-like birds. The surprising fact is that so few land birds have left any record of their presence in these beds that are so rich in mammal remains and that have been so extensively explored.

SUMMARY AND DEDUCTIONS

A collection of nineteen specimens of fossil birds from the Upper Miocene of Barstow, California, was studied. So far as known, there is no other bird material from these beds on deposit in American institutions. The material is well petrified but highly fragmentary; therefore generic and specific classification is attempted in but few instances.

A minimum of nine species is represented. A maximum of three of these fall in the general class of "land birds." Ducks make up the majority both of species and specimens. Two hawks, one flamingo, and one quail are represented.

Collecting stations yielding birds are widely distributed both in the horizontal and in the vertical sections of the formation. Mammal remains are abundant and indicate that only the Upper Miocene is represented.

Seasonal rainfall definitely greater than that of today is indicated. In a few instances lake waters persisted for a period sufficient to harbor aquatic mollusks and accumulate lacustrine sediments. These sediments were never of great thickness and were in turn covered by landlaid accumulations. Highly temporary rain water pools may have served as loafing grounds for drifting populations of water birds. Mild topography without marked drainage systems is postulated.

More pronounced desert conditions followed the uplift of the Sierra Madre Mountain barrier after the close of Miocene time and particularly during the Pleistocene. This barrier cut off the area from moisture-laden sea winds and at the same time caused a retreat of the coastline to approximately its present location.

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FOOD HABITS OF THE CALIFORNIA GULL IN UTAH

By CLIFTON M. GREENHALGH

The California Gull (*Larus californicus*) is generally revered in Utah for its well known role during pioneer times in helping to save the crops of the first settlers of Great Salt Lake Valley from crickets. Subsequently an interesting social taboo developed whereby the bird was rarely killed (Young, 1928). The famous Seagull Monument, erected on the Temple grounds at Salt Lake City to commemorate the role of the gull, has helped to keep the taboo alive. The first change in local feelings toward the gulls came with complaints against them because of their depredations on cherry crops in Davis County (Cottam, 1935; Sugden, 1937). Similar charges have come from Boxelder and Utah counties.

These birds have long been known to nest on several islands in Great Salt Lake (Behle, 1935, 1949). New colonies of gulls have of recent years been established at three waterfowl refuges on the east side of Great Salt Lake, namely Farmington Bay, Ogden Bay, and the Bear River Refuge. This has brought them in close contact with nesting waterfowl and the gulls are being accused of predations on ducks.

With attention being focused on these new problems, it seemed desirable to make a general study of the food habits of the California Gull. Little specific information was on record. Kalmbach (1914:6) reported on the contents of five stomachs and Cottam and Williams (1939:153) listed the contents of six stomachs of birds taken in the Great Salt Lake region but these were small samples. Accordingly a study was started by the writer in 1940. This was interrupted by the war but was resumed in June of 1946 when arrangements were made with the personnel at Bear River Migratory Bird Refuge to spend the summer working on the refuge and at the laboratory of the research division at the refuge headquarters. In addition to field observations, food items in the stomachs of California Gulls previously collected on the refuge were identified and further samples were taken. The results are presented here supplemented with occasional notes from the literature and interviews with farmers.

Thanks are due William H. Behle of the University of Utah for guidance in this study. I am indebted to several men at the Bear River Migratory Bird Refuge: Cecil Williams and Vanez Wilson were generous in providing facilities for me in 1946; Cecil Williams, Charles Sperry, Hortin Jensen, and Ralph Hervey were helpful in giving advice, collecting, and identifying food items. In my initial collecting around Salt Lake City I was helped by Jack Berryman, Rex Edward, Dan Gardiner, and Nathan Riser to whom I also express my thanks.

MATERIALS AND METHODS

The results herein presented are based mainly on an analysis of 529 stomachs. Of these, 132 were collected at Bear River Refuge in 1939 by the personnel at the refuge. The writer collected 47 in the Salt Lake City area in 1940, and 166 in 1941. These were taken either on Antelope Island in Great Salt Lake or west of Salt Lake City. Ten stomachs were taken each week from March 30 to August 10. By this time most of the gulls had migrated and specimens were difficult to obtain. In 1946, 184 stomachs were collected at the Bear River Refuge. Fifteen gulls were taken each time, again at weekly intervals.

The usual techniques were followed in preserving and handling the stomach contents whereby they were sorted, dried and measured volumetrically in terms of cubic centimeters. First, the entire stomach contents, including debris and gravel, were considered on the basis of 100 per cent. After the gravel and debris had been measured

and removed, the food items were computed on the basis of 100 per cent. All material was measured to the closest 0.1 cc. If there were items mixed to a degree where it was not practical to separate them, an estimate was made of the individual items. No stomachs were eliminated in this study.

DISCUSSION AND EVALUATION OF ITEMS

Gravel.—This made up a bulk of 357.70cc. which was 8.61 per cent of the total. It was found in 427 of the 529 stomachs. Also included in this category were the following items. In one instance a piece of iron was found. Sand was found in many of the stomachs, usually being associated with earthworms and other earth-dwelling animals. Mollusk shells appeared occasionally. They were bleached and there were no signs of assosociated flesh. In general the stomachs that were gorged with food had little or no gravel, whereas large amounts of gravel were found in the empty or nearly empty stomachs.

Debris.—This made up 327.45cc. or 7.89 per cent of the total. Items classified as debris are those that may have been inadvertently taken in while feeding. Such items identified were paper, sawdust, chips of wood, grains, portions of bullrushes, sedges, chara, dandelions, pondweeds, and various plant fibers. Feathers were considered as debris unless skin or flesh was also present in which case the entire unit was considered as food. Special care was taken to prevent feathers of the gull being mixed with stomach contents. Nevertheless gull feathers did show up in stomach contents. This may serve as a clue to the reason for so much debris. The gull has the habit of picking objects at random while resting or feeding and then ingesting them. In March and April when nesting sites were being chosen there was a higher percentage of debris than in the rest of the season.

Food.—All items in the stomach contents other than gravel and debris and which possessed nutritional values were considered as food. This made up 3468.15cc. or 83.50 per cent of the total. The various items were subdivided to expedite handling.

Birds and birds' eggs: 155.60cc. (4.49 per cent). This study indicates that the gulls are commonly predacious on birds and birds' eggs. Both young and adults are taken. Some land birds are preyed on as well as marsh-dwelling birds.

Seven ducklings were found in the stomach contents, for which the measurement was 35.20cc. Three young coots were also found with a volume of 51.40cc. There were two occurrences of passerine birds with a volume of 35.20cc. One of these was a sparrow. In addition, a day-old turkey that had been regurgitated by a young gull was picked up by W. H. Behle at a Farmington Bay colony on June 16, 1945.

Five gull stomachs contained duck feathers and skin of adults. The measurement was 4.40cc. While working during a botulism outbreak at Bear River Refuge, the writer saw many ducks that had been attacked by gulls. The uropygial gland at the base of the tail was the area most often injured. According to Charles C. Sperry, even if these birds were to recover from botulism, they would die in a few weeks from drowning because of the subsequent lack of oil for waterproofing the feathers.

There were no egg remnants in the stomachs of gulls taken before 1946. Of the 184 stomachs collected at the Bear River Refuge in 1946, thirty contained eggs of other species of birds. In twenty-five of these there were twenty-six duck eggs with a volume of 16.50cc. There were also two other eggs measuring only .50cc. that could not be identified as to species since there were only remnants of lining and egg contents present. Avocet eggs were found in two instances: one stomach contained two eggs, the other, one. Whole pheasant eggs have been found in full nests at Farmington Bay during banding operations. Sugden (1947) has recorded some data bearing on these exotic eggs locally and Twomey (1948) elsewhere. There was only one case of pheasant eggs found

in this study, the measurement being 2.80cc. In 1941 the foreman of the ranch on Antelope Island told the writer that gulls were attacking and destroying the eggs of his turkeys. The gulls even prey on eggs of their own kind. Although fragments of only one gull egg were found in one stomach, the destruction of eggs of their own species in disturbed colonies has been observed many times by the writer. As to the predation by California Gulls on the eggs of associated species in the colonies on the islands of Great Salt Lake, if the nesting colonies are disturbed and the incubating adults are frightened from their nests, the gulls will destroy the unprotected eggs of pelicans, herons, cormorants and any other birds present. References to such behavior have been frequently made in the literature (Behle, 1935; Bailey, 1935; Sugden, 1936).

The indications are then, that the California Gull will eat or destroy any egg that may be left unprotected in the vicinity of its nesting sites. For the most part I should say that these eggs are secured in close proximity to the gulls' own nesting sites, but in some instances they are taken far afield.

Carrion and garbage: Together these items totaled 438.77cc. (12.65 per cent). Some clues as to when to consider an item carrion were the presence of carrion beetles, fly larvae, and the odor of advanced decay. If the skin or flesh was in good condition, the item was placed in the previous category of "birds and birds' eggs."

Birds were represented among the carrion by one pintail duck and one sparrow. The total volume for these two items was 71.70cc. Two remnants of mammals which were doubtless also eaten as carrion, proved to be skunk and sheep as indicated by hair and wool. These two items had a volume of 76.00cc. The largest item of carrion, however, was fish. The gulls occasionally dive into the water for food and may fish from the surface, but fish are generally picked up near the shoreline of the rivers and lakes. In many cases therefore, the fish were in an advanced state of decomposition. Where there were no identifiable characteristics, they were grouped under miscellaneous fish carrion. Such remnants were found in fourteen stomachs, and measured 23cc. Fifteen carp were found in eleven stomachs with a volume of 156.45cc. Suckers were found in three stomachs; four individuals measured 18.80cc. There was only one catfish. It had a volume of 0.80cc. Meat fragments of unidentified birds occurred in twenty-two stomachs and measured 71.10cc. Cottam (1945:216) has described California Gulls eating ground squirrels and prairie dogs killed by cars along highways as well as the taking of a crippled chipmunk.

Garbage is a category devised to include a miscellaneous lot of vegetative matter of no great food value that may have been picked up at random. A considerable part of this consists of fruit debris. For instance, apple peels were found in two stomachs with a measurement of 3.90cc. In one instance a banana peel was present with a measurement of 7.00cc. In addition, there was a miscellaneous amount of fruit peel found in four stomachs with a measurement of 2.00cc. Brown beans were found in one stomach with a volume of 7.00cc. Even tomato sauce occurred with the beans! Bread was found in combination with other miscellaneous items like potato chips and apple peel in eleven stomachs. No separate measurement was taken of these since the items were so mixed that it was not practical to separate them. The measurement of this mixture was 19.20cc. A whole frankfurter was found in one stomach, the volume being 19.20cc. The prevalence of these food items is easily accounted for by the gulls' practice of congregating around schools and parks where lunches are eaten.

Items of carrion and garbage are important as indicating the role of the gulls as scavengers. As such they help to clear away debris and organic matter which otherwise might be a source of pollution.

Cherries: These totaled 182.95cc., or 5.28 per cent. Forty-one stomachs contained 311 cherries. At the nesting sites stones were frequently found in piles of twenty to forty adjacent to each nest.

At Brigham City, Utah, the writer interviewed fifteen farmers, inquiring as to the damage that the gulls were doing to the cherry crop. The majority gave the answer that about one-fourth of the early cherries were eaten or destroyed by the gulls. Some stated that each year the attacks on the orchards were becoming greater and that during the season it was a full time job to patrol the orchards.

A few farmers reported depredations on the late cherry crops. However, it would seem that damage at this time is relatively less serious because there are more late cherries. Consequently the damage is extended over a larger area and the loss is not so great for any one farmer. The writer's data from analysis of stomach contents indicate that cherries are eaten throughout the season. Beck (1947:46) estimated that the quantity of cherries eaten at the Geneva Steel Colony in 1946 by some 8000 birds amounted to 1507 pounds.

The farmers in Boxelder County also reported damage to strawberries. The gulls were reported to fly only into the larger patches, where they would pick at the fruit that showed signs of ripening. The fruit picked at but not ingested subsequently became shrivelled.

Earthworms (*Lumbricidae*): 70.75cc. or 2.04 per cent. One of the common sights in northern Utah in the spring is that of flocks of California Gulls in the fields following in the wake of the farmers' plows. One might expect, therefore, to find a large proportion of earthworms in the gulls' diet. Instead, earthworms comprise a small amount of the food. There were only seventeen stomachs containing worms. A numerical count was not made because in most instances the worms were in several pieces. There was usually sand in the stomach when earthworms were present.

Arthropods (*Arthropoda*) (*Miscellaneous*): 12.50cc. or 0.36 per cent. All arthropods that do not belong to the class Insecta are placed in this group. The group is not important in terms of quantity. There were two stomachs that contained spiders (Arachnida) with only a trace in volume. The measurement of brine shrimps (*Artemia*) was 2.00cc. The eating of brine shrimps has been reported by Behle (1935). There were eighty-one isopods in one stomach, which measured 10.50cc. Most of this group are considered to have been picked up accidentally.

Insects (*Insecta*) (*Miscellaneous*): 8.35cc. or 0.24 per cent. All insects that were found in small numbers are grouped together in this category, none being present in great enough volume to be discussed independently. For instance, caddisflies (Trichoptera) were found in only one stomach, where they had a volume equal to one-half of the total of that particular stomach.

Beetles (*Coleoptera*): 162.90 cc. or 4.70 per cent. Ground beetles (Carabidae) were the most common beetles found. There were 1160 individuals found in 175 stomachs, with a measurement of 65.90cc. Tiger beetles (Cicindelidae) constitute another important group that are predacious on other insects. In forty-two stomachs, there were 538 individuals that measured 34.10cc. Water beetles were represented by two families. Members of the Dytiscidae were found in six stomachs with a count of 219 individuals, and a measurement of 2.90cc. Hydrophilids were found in larger numbers; in sixty-one stomachs the measurement was 14.35cc. for 608 beetles. Dermestid beetles (Dermestidae) were found in twelve stomachs, the count being 473 individuals which measured 11.05cc. In seventeen stomachs there were 538 weevils (Curculionidae) that measured 17.55cc. The scarab beetles (Scarabaeidae) were found in smaller amounts. There were

108 beetles of this type in twenty-two stomachs; the volume was 11.60cc. There were other coleopterans found, but they were in very small amounts. The families represented are click beetles (Elateridae), rove beetles (Staphylinidae), and darkling beetles (Tenebrionidae). There were only seventeen specimens of beetles that were not identified because of the lack of determining parts.

Flies (Diptera): 187.45cc. or 5.40 per cent. Groups like the robber flies (Asilidae), long-legged flies (Dolichopodidae), house flies (Muscidae), and horse and deer flies (Tabanidae) were eaten in minute amounts, whereas the midges (Chironomidae) and brine flies (Ephydridae) are well represented. There were eighty-seven stomachs that contained 18,418 chironomids. The volume of this group was 132.50cc. Cottam (1945) has reported observing gulls eating chironomids. Examples of the family Ephydridae were found in twenty-one stomachs with 3249 individuals present having a measurement of 26.30cc. Behle (1935) has described how the gulls capture these flies while the latter swarm in large numbers. Crane flies (Tipulidae) were represented by 4765 individuals in five stomachs. These flies measured 22.3cc.

Cicadas, etc. (Homoptera): 89.90cc. or 2.59 per cent. In the collections of 1941 there were five stomachs that contained eighty-two specimens of the family Cicadidae. This is the only family represented in the order, and the measurement was 89.90cc.

Dragonflies and damselflies (Odonata): 313.20cc. or 9.03 per cent. They are apparently an important item in the diet of gulls. Dragonflies (Anisoptera) were noted in one instance, but damselflies (Zygoptera) were found in forty-nine stomachs. The total measurement for the latter was 313.20cc.

Grasshoppers and crickets (Orthoptera): 1845.80cc. or 53.22 per cent. Only one individual cricket of the family Gryllidae was found. All the rest of the orthopterans belong to the family Locustidae (grasshoppers and migratory locusts). In 198 stomachs there were 2839 grasshoppers with a volume of 1845.80cc. This is the greatest volume of any one group of animal food found in the study. The greatest number of grasshoppers was eaten in the latter part of June and the month of July. Some stomachs seemed to be filled to utmost capacity. When grasshoppers were found, there was very little else—although gravel was found in a few instances in small amounts.

The finding of but one cricket is misleading as to the role of the California Gulls in controlling this type of insect in the Great Salt Lake region. Knowlton (1941) has observed gulls eating Mormon crickets in recent years. He thinks the gulls are as important today in this respect as they were in pioneer times. Sorenson and Thornley (1938:70) have described the congregation of the gulls at an area of cricket infestation in Tooele and Juab counties.

In contrast, the role of gulls in controlling grasshoppers is not as effective as might be supposed from the figures. When the young gulls are able to fly, they begin a migration to the west coast about mid-July (Woodbury, Behle and Sugden, 1946). Some of the adults seem to migrate at the same time as the young. After July 15 it is difficult to collect gulls because the numbers have been so reduced. The gulls have migrated, therefore, when the locusts are becoming a real menace. In the case of the Mormon Cricket, it is a different story, for the eggs are laid in the fall and hatch early in the spring.

According to the quantitative data for volume and per cent, it would appear that 50 per cent of the food eaten by gulls consists of grasshoppers. This, however, is misleading, for the size of the insect, and the numbers taken at one time must be considered. When the gull eats grasshoppers, the tendency is to engorge them in such great numbers that the stomach becomes distended and the volume is five to ten times the amount found in the average stomach.

Since this study was made, Beck (1947:46) estimated that on June 17, 1947, the

gulls at the Geneva Steel Colony numbering 8000 consumed 154,472 grasshoppers which would weigh about 305 pounds.

SUMMARY AND CONCLUSIONS

This study of the food habits of the California Gull (*Larus californicus*) in Utah was based on an evaluation of 529 stomachs collected in four years in the vicinity of Salt Lake City and the Bear River Migratory Bird Refuge. In the analysis of stomachs,

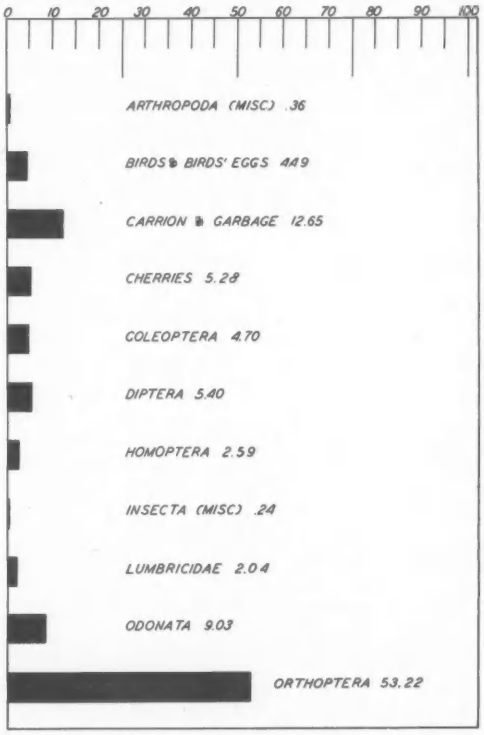

Fig. 1. Percentages of the larger categories of food items in 529 stomachs of the California Gull.

the contents were divided into three main categories (gravel, debris, and food), and their percentage representation computed with results as follows: gravel 8.61, debris 7.89, and food 83.50. The food items consisted of the following, their abundance being expressed as portions of 100 per cent: birds and birds' eggs, 4.49; carrion and garbage, 12.65; cherries, 5.28; Lumbricidae, 2.04; Arthropoda (miscellaneous), 0.36; Insecta (miscellaneous), 0.24; Coleoptera, 4.70; Diptera, 5.40; Homoptera, 2.59; Odonata, 9.03; and Orthoptera, 53.22.

These data indicate that California Gulls have an omnivorous diet. The presence of much carrion and garbage suggests that this gull is in large part a scavenger. Animal food predominates but changing food habits of recent years have caused gulls to do

some damage to the cherry crops of northern Utah. The greatest damage is to the early crops, but cherry flesh appears regularly in their crops until July. Grasshoppers (Orthoptera) are the most abundant food items eaten.

The finding of bird remnants and birds' eggs opens up the problem of the effect of the gulls' nesting on waterfowl refuges. Many of the gull stomachs collected on the Bear River Refuge contained birds or eggs. Comparison of the data from the stomachs of the gulls in the vicinity of Salt Lake City, which birds presumably nested on the islands in Great Salt Lake, with those from gulls definitely nesting on the Bear River Refuge, indicated the former to be less detrimental to waterfowl in this respect.

When the gulls were restricted to their natural island nesting sites and had to forage widely over the entire area, they constituted no particular problem. In recent years they have become concentrated on man-made refuges close to nesting waterfowl and also near extensive orchards, many of which have been planted in recent years. They have adjusted themselves to a food supply somewhat different from that formerly utilized, provided by man himself, and accordingly locally they do serious damage.

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NOTES ON MEXICAN BIRDS FROM THE STATES OF DURANGO AND ZACATECAS

By J. DAN WEBSTER and ROBERT T. ORR

Between June 20 and July 31, 1950, the senior author collected birds and mammals for the California Academy of Sciences in the states of Durango and Zacatecas, México. The areas in which field work was carried on were in the southern part of the Sierra Madre Occidental Biotic Province as defined by Goldman and Moore (1946:349) except for a few observations in the Chihuahua-Zacatecas Province in eastern Durango. Four or five of the major vegetation types as mapped by Leopold (1950) were involved.

Since no comprehensive report has ever been published on the birds of Zacatecas and none on the birds of Durango since W. DeWitt Miller's report (1906) on the Batty collection, comments on the distribution and taxonomy of certain species obtained or seen in these two states in 1950 seem warranted. An asterisk indicates that a record is a new one for the state of Zacatecas; a dagger indicates a new record for the state of Durango.

Lerdo is a city in central eastern Durango; observations near here were made in desert valleys to the south and east, where the vegetation is chiefly dwarf agave, creosote bush, and mesquite and the elevations a little over 4000 feet. Yerbanis and Tmalpan (=Tapona) are towns on the Lerdo-Durango highway, in the mesquite-grassland plains. The city of Durango is on a mesquite-grassland plain at an elevation of 6200 feet. Mezquital, 44 miles south of Durango City at 4700 feet, is in an arid, near-tropical valley heavily grown to thorny scrub.

The next seven localities are in the Sierra Madre Occidental, west of Durango City. Arroyo Mimbres is in the yellow pines, but along the bottom of the arroyo, at 7600 feet, are a good many large oaks. El Salto is an old, but still active, lumber mill town on the 8300-foot plateau and ten miles northeast is Coyotes, another mill town. The country around El Salto and Coyotes has been logged over and burned many times but still supports a good growth of moderate-sized yellow pines, with a ground cover of sparse grass, or, in spots, of a dwarf *Vaccinium*; several open areas become wet meadows late in the rainy season in July and are heavily covered with tall grass; some rocky hillsides support a growth of large, spreading oaks. Quebrada del San Juan is a deep canyon 19 miles north-northeast of El Salto, where the logging road descends to 6500 feet; collecting was done in a cool, fir-grown ravine on the south side of the canyon. San Luis is a lumber mill 30 miles northwest of El Salto; collecting was done in a cool ravine, in fir-oak-madrone-yellow pine forest at about 8700 feet. Cerro Huehuento is the highest mountain in Durango, 10,335 feet. There is a good growth of fir, aspen, and white pine near the top, which has not been logged. Cerro Prieto, 10,171 feet, and 45 miles west-northwest of Durango City, has been logged to the summit, but there remains a patch of fir, aspen, and white pine on the north slope, and the yellow pines are regrowing well on the other slopes.

In the extreme northern part of the state of Zacatecas, collecting was done on Cerro Pachon, 11,700 feet (U. S. Air Force Chart, 1949 edition), just east of the nearly abandoned town of Chalchuites. The lower slopes of the mountain are grassy, with some mesquite and juniper, but above 9000 feet there is a dense growth of oak, manzanita, and madrone. About the peak there was formerly a pine forest, and even a few firs, but it was cut many years ago and only stumps and a few saplings remain. Near Sombrerete, camp was established beside a stream three miles southwest of town, at 7700 feet, in a heavily-

grazed area overgrown with mesquite and prickly-pear; all records for Sombrerete were made within a mile of this camp.

We wish to express our appreciation to Alden H. Miller of the Museum of Vertebrate Zoology for permission to use many specimens for comparison, and to record here two specimens from that collection. Thomas R. Howell checked the subspecific identity of two species of warblers for us at the Dickey Collection of the University of California at Los Angeles. James H. Maysilles and Edwin Steiner were helpful traveling and camping companions. We appreciate the courtesy shown by officials of the Mexican government in granting us permission to collect.

†*Falco femoralis*. Aplomado Falcon. A single individual was seen pursuing a Red-tailed Hawk over a meadow near Coyotes on June 27.

†*Polyborus cheriway*. Caracara. One was seen beside the highway eight miles west of Lerdo on July 31.

**Callipepla squamata squamata*. Scaled Quail. Fairly common near Sombrerete; an adult male was taken on July 19. This species has been recorded from all adjacent states (Friedmann, Griscom, and Moore, 1950:73).

†*Tringa melanoleucus*. Greater Yellow-legs. One was seen wading in a wet meadow near Coyotes on July 27.

†*Larus pipixcan*. Franklin Gull. Friedmann, Griscom, and Moore (*op. cit.*: 105) list this gull in México as "A transient, rarely alighting, great flocks passing overhead in late April, and again in August and September." It is of interest, therefore, to record an adult male taken on June 26, near Coyotes, as it was on the ground in a short-grass meadow surrounded by small pines. The testes were 4 mm. long; the nuptial plumage is complete except for the outermost primaries.

†**Tyto alba*. Barn Owl. In Durango, one was seen by daylight on July 6, ten miles west of Lerdo. Very early the next morning, four were seen by the senior author while driving back from the hills about ten miles south of Lerdo. In Zacatecas, one was seen or heard each evening from July 19 to 23, near Sombrerete.

Chordeiles minor henryi. Nighthawk. Two breeding adults, male and female, from the pine forests of southern Durango, near the extreme southern edge of the range of the species, are less gray than any examples of *C. m. henryi* examined from Arizona and northwestern Chihuahua.

Cypseloides niger borealis. Black Swift. Since there are few records for this species from México the following observations in Durango seem worth recording: adult male taken from flock of four birds, July 25 near Mezquital; observed June 25 near Coyotes (one bird), July 24 six miles west of Durango City (flock of 20), July 24 near Mezquital (one bird).

†*Trogon mexicanus clarus*. Mexican Trogon. A single male was secured and several were heard calling in the fir forest on Cerro Huehuento on July 3. Although subspecific identification of males is impossible (see Griscom, 1932:57), a female in the collection of the Museum of Vertebrate Zoology from El Batel, Sinaloa, only 40 miles to the southwest, is clearly of the northern race *clarus*.

Sayornis saya saya. Say Phoebe. Although Miller (1906:168) records this species as breeding in Durango in May, the southern extent of its summer range given in the 1931 A. O. U. Check-list is Chihuahua and Sonora. Hellmayr (1927:59) does not mention the species as breeding on the Mexican mainland, while Davis (1945:277) suggests the possibility of its breeding in Veracruz. It is of interest to note, therefore, that on July 22 at least three nesting pairs were observed near Sombrerete. A juvenile, still being fed by the parent, was taken on that day and an adult female on the following day.

†*Corvus cryptoleucus*. White-necked Raven. On June 21 a few were seen about the irrigated areas near Lerdo and four more single birds were seen along the highway across the desert areas of eastern Durango and in the grasslands as far west as Tmalpan.

†*Sitta pygmaea chihuahuae*. Pigmy Nuthatch. An immature male was taken near Coyotes on July 28. There is another specimen in the Museum of Vertebrate Zoology, taken near El Salto on March 19, 1950.

†*Telmatodytes palustris*. Long-billed Marsh Wren. In a cattail-tule marsh twelve miles northeast of Durango City, July 5 and 30, two males were singing.

Salpinctes obsoletus. Rock Wren. This species was common near Sombrerete where an adult male

was taken on July 13. A male in juvenal plumage, taken near Durango City, shows the dark-colored wings and gray (less buffy brown) back and pileum claimed by Ridgway (1904:648) for his race *notius* (= *latisfasciatus* Lichtenstein according to van Rossem, 1934:416). Comparison was made between a series of 110 juvenal-plumaged specimens of the race *obsoletus* from western North America. and five juvenal-plumaged specimens from Guerrero and Durango in the California Academy of Sciences and the Museum of Vertebrate Zoology collections, and each of the latter could easily be picked out. Whether a race which can be recognized only on the basis of juvenal plumage merits nomenclatorial recognition is open to debate.

**Toxostoma curvirostre celsum*. Curve-billed Thrasher. Moore (1941:212 ff.) in his description of *T. c. celsum* made no comment on the subspecific identity of thrashers from Zacatecas although he indicated that the race *celsum* extended south "probably through Aguascalientes to northwestern Guanajuato and extreme northeastern Jalisco." Two adult males from near Sombrerete, taken on July 13 and 20, respectively, agree with his description of the race *celsum* and show no differences from southern Durango specimens.

†*Catharus occidentalis olivascens*. Nightingale Thrush. An adult male was taken on June 30 in the Quebrada del San Juan. Another was seen near the top of Cerro Prieto on July 10.

Ridgwayia pinicola. Aztec Thrush. Because of the rarity of this species in the northern part of its range, the taking of an adult male at San Luis on July 1 seems worth mentioning.

†*Vireo solitarius pinicolus*. Solitary Vireo. Although this species had previously been known from Durango, van Rossem (1934:467) recorded the race *pinicolus* south only to southern Chihuahua. Three adults taken near Coyotes on June 26, 28, and July 29 in hillside growths of oaks are clearly referable to this subspecies.

†*Vireo gilvus*. Warbling Vireo. One was seen on a rocky hillside sparsely scattered with pines and oaks on June 29 near Coyotes.

Icteria virens auricollis. Chat. A breeding male was taken, and several others were heard singing, in the Mezquital Valley on July 26. The specimen is slightly grayer dorsally, slightly darker on the pileum and ear coverts, and definitely longer-billed (culmen 16.5 mm.) than breeding material from southern Arizona and a bird from Guerrero taken on June 3, and contrasts strongly with a large series from California. It does not, however, differ in other measurements (wing 77, tail 80 mm.) from *auricollis*. Thomas R. Howell compared this specimen with the type of *I. v. tropicalis*. He found the latter to be much smaller than our specimen.

†*Dendroica graciae*. Grace Warbler. One was seen on June 23 and 24 in the oaks in Arroyo Mimbres.

Geothlypis trichas chryseola. Yellow-throat. Several were seen, and two singing males were taken, July 5 and 30, in a marsh twelve miles northeast of Durango City. The specimens differ from *chryseola* of southern Arizona in being slightly grayer on the belly and flanks, in having a narrower white frontal band which is more streaked with yellow, and in having a slightly heavier bill. Thomas R. Howell compared our specimens with two adult males of the race *riparia* (one the type). He concluded that the Durango specimens were nearer *G. t. chryseola* (see van Rossem, 1941:292, and Lea and Edwards, 1950:268).

†*Myioborus miniatus miniatus*. Red-bellied Redstart. Two singing males, one of which was collected, were seen in Quebrada del San Juan on July 1. On July 10 three singing males were seen near the top of Arro Prieto.

Ergaticus ruber ruber. Red Warbler. There are few records for this species in the northerly part of its range; in fact the only Durango record known to us is an old specimen in the British Museum mentioned by Sharpe (1885:406) and Ridgway (1902:760) from "Cuidad Durango" and probably actually taken high in the Sierra Madre to the west. Our records include two seen, and an immature taken, in the firs on Cerro Huehuento on July 2 and two seen there the next morning.

†**Icterus parisorum*. Scott Oriole. In Durango, one was noted on June 21 southwest of Yerbanis and one was seen on July 25, thirty miles south of Durango City at 6000 feet in scattered junipers and mesquite. In Zacatecas, a male was singing in scattered oaks at about 9700 feet on Cerro Pachon on July 14; at camp near Sombrerete one sang all morning every day from various bushes nearby and was often answered by another from a low hill two hundred yards to the north.

†*Tangavius aeneus*. Bronzed Cowbird. Two small flocks were seen near Mezquital on July 26. Earlier, a pair was seen on June 21 ten miles northeast of Durango City.

**Guiraca caerulea eurhyncha*. Blue Grosbeak. An adult male of a mated pair was taken in scrub oaks beside open fields at 7800 feet on July 8, twenty-five miles west of Durango City. On July 16 an adult female of a mated pair was taken near Sombrerete. In addition, a few others were seen on the plains near Durango City. On the basis of comparative material examined we are inclined to concur with Amadon and Phillips (1947:580) regarding the inadvisability of recognizing *G. c. deltarhyncha* van Rossem.

Carpodacus mexicanus. House Finch. Moore (1939) does not list any specimens from Zacatecas. A single adult male, taken on July 23 at Sombrerete, is between the ranges of the races *coccineus, centralis,* and *potosinus,* as indicated by Moore (*op. cit.*: 182). In color it most closely approaches comparable specimens of *C. m. coccineus* and differs from a single male of *C. m. centralis* from Michoacán that was examined. The wing of the specimen from Zacatecas measures 81 mm., which is nearer to the averages of *C. m. potosinus* and *centralis* than to that of *coccineus*.

†*Volatinia jacarina*. Blue-black Grassquit. A pair was seen at close range in the brush fifteen miles north of Mezquital on July 25.

**Spinus psaltria psaltria*. Arkansas Goldfinch. An adult male and female were taken on July 23 at Sombrerete.

†*Atlapetes pileatus dilutus*. Rufous-capped Sparrow. An adult female was taken at Quebrada del San Juan on July 1. This specimen, when compared with a large series of breeding adults of *A. p. pileatus* from Guerrero, is decidedly paler below. The wing measures 59 mm. which is close to the average for *A. p. dilutus* given by Sutton, Pettingill, and Lea (1942:202).

**Pipilo fuscus*. Brown Towhee. Two adult males and an adult female were taken near Sombrerete on July 12 and 16. They are indistinguishable from a male taken five miles east of Cerro Prieto. Moore (1942:47) considered specimens from northern Durango as intermediate between the races *potosinus* and *perpallidus*. We find that these four birds from northern Zacatecas and southern Durango fall in the same category.

**Spizella atrogularis atrogularis*. Black-chinned Sparrow. A few were seen every day at Sombrerete, July 13 to 24. An adult male was taken on July 17 and the following day a courting pair was collected.

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Hanover College, Hanover, Indiana, and California Academy of Sciences, San Francisco, California, February 21, 1952.

FROM FIELD AND STUDY

Northern Phalaropes and Xantus Murrelet Associated with Fishes.—In August and September of 1951 the fisheries research vessel "Yellowfin" was operating in the area between Cedros and Asunción islands, Baja California, México. While trolling offshore Asunción Island (27° 4.6′ N, 114° 17.2′ W), two common dolphins (*Coryphaena hippurus*) were taken at 4:15 p.m. on August 29. One of these, a male, had its stomach stuffed with a conglomerate which was found to be the distinguishable remains of four Northern Phalaropes (*Lobipes lobatus*). Digestion had proceeded to the stage where dorsal surfaces of the skulls were gone. Bills, feet, and feathers were in such good condition as to allow comparison with museum specimens and to verify the field identification. Apparently these birds had been taken from a group at about the same time.

On September 5 at 2 a.m. the ship was occupying a station off Cedros Island. A Xantus Murrelet (*Endomychura hypoleuca*) was observed swimming under water amidst a mixed school of four-inch anchovies (*Engraulis* sp.) and Pacific sardines (*Sardinops caerulea*). These fish were slowly milling under a 1500-watt bulb suspended over the side to attract them. One characteristic posture was that in which the bird dipped its head under the water, stretched its neck, and seemed to peer intently into the brilliantly lighted area. After this was repeated several times it would dive and move about half a foot beneath the surface in irregular circles six feet in diameter. It never took a fish, but occasionally it pursued one. The bird swam with its wings rigidly half open and feet trailing. The feet were never seen to move. Since the bird was observed from directly overhead, any movement of the feet in the vertical plane could not have been easily seen.

Sometimes when the murrelet was sitting on the water, one of the small fishes would "flip" behind it. This would alarm the bird, and it would fly off a dozen feet in the typical jerky, uncertain flight we have observed seabirds display under bright lights at night.—ROBERT L. EBERHARDT, *Bureau of Marine Fisheries, Department of Fish and Game, San Pedro, California, February 15, 1952.*.

Geographic Variation in the Horned Grebe.—The Horned Grebe (*Colymbus auritus*) has been consistently treated in the literature as a uniform holarctic species. This is at variance with its congeners, *C. caspicus* and *C. grisegena*, both of which have differentiated into New and Old World subspecies. It seemed logical to compare samples of the New and Old World populations of *C. auritus* to determine whether a similar differentiation had taken place. Examination of the extensive series of this species in the American Museum of Natural History and the United States National Museum revealed definite characters by means of which these two populations of Horned Grebe may be separated.

European specimens average darker and blacker on the back than American specimens, which are grayer. The contrasting light gray feather edgings of the back, well marked in American birds, are darker and less conspicuous, sometimes virtually absent in European specimens in comparable plumage. In breeding plumage, the brownish stripe through the eye averages much darker in European birds. All Old World specimens seen have the preorbital part of the stripe dark chestnut and the postorbital part of dark buff with a chestnut tinge. Most New World birds have this stripe much paler, even the preorbital part being buff. A few extreme New World birds approach the coloration of Old World birds in this respect.

In nonbreeding plumage the darkness of the back of the Old World birds, as just described, is retained. The most obvious difference, and the first one which became apparent to me at the beginning of this study, is in the color of the crown. In Old World winter specimens the crown is a glossy black, whereas the crown of New World birds in this plumage is a dull gray. There is no discernible difference in size.

Exact delineation of the ranges of the two forms has not been possible with the material thus far available to me. The type locality of this species is Sweden, and Scandinavian specimens examined agree with other European specimens in showing the color characteristics. Winter specimens from China, Korea and Japan are somewhat variable, and it may well be that the easternmost Asiatic breeding populations are intermediate. Two birds from Bering Island are referable to the New World form. It is possible that some Horned Grebes from the northwesternmost portion of the American breeding range may follow the Asiatic coast of the Pacific on migration.

Formal description of the American population as a new subspecies is not necessary, as there are several names in the synonymy of the Horned Grebe which apply wholly or in part to the New World birds. Of these, the earliest appears to be *Colymbus cornutus* Gmelin (Syst. Nat., 1 (2), 1789:591). This name was based on earlier descriptions by Edwards (Nat. Hist. Birds, 2:96, pl. 96), Pennant (Arct. Zool., 2:497) and Latham (Gen. Syn. Birds, 3 (1):287, pl. 91). According to Hellmayr and Conover (Cat. Birds. Amer., 1(2), 1948:30), Gmelin based his *cornutus* partly on the "Eared Dobchick" of Edwards, the left-hand figure in Edwards' plate 96. James L. Peters has informed me, however, that this figure, based on "several found in the market of London in the hard winter of 1739," definitely portrays an Eared Grebe. The right-hand figure, the "Black and White Dobchick" of Edwards, is evidently a Horned Grebe in winter plumage according to Peters. The figured bird was taken "about the large ponds of Hampstead near London." The descriptions by Pennant and Latham, based on birds from Hudson Bay, unmistakably apply to Horned Grebes. If Hellmayr and Conover were not in error in their designation of Edwards' left-hand figure as the partial basis of Gmelin's description, *Colymbus cornutus* would be a composite name referring to Eared Grebes from London and Horned Grebes from Hudson Bay. If the right-hand figure in Edwards' plate were the partial basis of *Colymbus cornutus*, the name would be a composite of two subspecies of Horned Grebe. However, Hellmayr and Conover (*loc. cit.*) have restricted the type locality of Gmelin's name to Hudson Bay, thus fixing the identity of *Colymbus cornutus* as the bird described by Pennant and Latham, the New World Horned Grebe.

The two subspecies of Horned Grebe may thus be known as follows:

Colymbus auritus auritus Linnaeus. Type locality, Sweden. Northern Europe and Asia, probably intergrading with *cornutus* in eastern Asia.

Colymbus auritus cornutus Gmelin. Type locality, Hudson Bay. Northern North America.

James L. Peters was good enough to examine old ornithological works not available to me, and gave much helpful advice. Thanks are also due to Drs. Herbert Friedmann and Dean Amadon for help and advice on various phases of this study.—KENNETH C. PARKES, *Laboratory of Ornithology, Cornell University, Ithaca, New York, April 19, 1952.*

Northward Extension of Range of the Acorn Woodpecker in Oregon.—The Acorn Woodpecker (*Balanosphyra formicivora*) is an abundant resident of the interior valleys of the Rogue and Umpqua rivers of southwestern Oregon, and ranges, though less abundantly, into the southern portions of the Willamette Valley. Gabrielson and Jewett (Birds of Oregon, 1940) record a bird from Lane County, and more specifically, Gullion (Condor, 53, 1951:140) gives Richardson Butte, which is some 12 miles northwest of Eugene, Lane County, as the northern limit of range.

Attention was directed to an isolated one-acre grove of Garry oaks (*Quercus garryana*) on the property of Oregon State College, one mile west of the campus in Corvallis, in July, 1950, when a fleeting glimpse of a woodpecker indicated the presence of this species. During May and June, 1951, two birds, a pair, were observed at close range on numerous occasions, usually perching on fence posts on the warm western edge of the grove in the afternoons. On May 18 the birds were actively engaged in catching insects, both by darting into the air in the manner of a flycatcher and by dropping to the surface of an adjacent roadbed. The insects were then deposited in a pocket in the top of a weathered cedar post. When a bill-full had been thus collected the woodpecker would disappear among the foliage of the oaks. Search from the ground, and on June 7 with the aid of climbing irons, disclosed numerous excavations varying from a few to several inches in depth, both old and recent, in dead oak limbs throughout the grove. The nest remained undiscovered. Stores of badly rotted and weathered acorns indicated the species had been present in years past. By June 30, when observations were discontinued, no young had been seen.

The presence of an isolated breeding pair of this social species 30 miles north of the population in Lane County reported by Gullion may be a step in the northward colonization along the Willamette Valley where abundant oak groves and woodlands would appear to meet the requirements for food and nesting sites. However, the pair here observed possibly represents only a fringe of the species population that may be limited by some factor other than the presence or absence of oaks.—KENNETH M. WALKER, *Department of Biology, College of Puget Sound, Tacoma, Washington, February 18, 1952.*

English Sparrow Feeding Young Eastern Kingbirds.—About 4:30 on the afternoon of June 16, 1951, I observed a female English Sparrow (*Passer domesticus*) feeding three young Eastern Kingbirds (*Tyrannus tyrannus*). The young kingbirds were able to fly although only awkwardly. They were perched on the telephone lines at a busy intersection about three miles from downtown Shreveport, Louisiana.

When first observed, the sparrow was feeding one of the young birds. I watched the birds for approximately forty-five minutes from a distance of twenty to forty feet. When the sparrow appeared with food, the kingbirds converged on it begging lustily, wings fluttering. The hungry kingbirds overwhelmed the sparrow, pushing her off the wire when she brought food. The sparrow flew off into the grass and weeds along the roadside and on vacant lots near by. At intervals of five to ten minutes she returned with food. Because the kingbirds shifted positions, I was not able to determine whether the sparrow was feeding all three kingbirds or only one of them. In the course of the observation the sparrow brought food five or six times.

On the morning of June 18 the kingbirds were again seen on the wires at the same intersection. On June 21 one young kingbird appeared in the yard of my sister, about one hundred yards from where I had seen the three young birds. A female sparrow was feeding this kingbird. My sister put out bread and the kingbird came with the flock of sparrows and was fed by one female sparrow. Whether the kingbird was fed by more than one sparrow was not determined for certain.

Apparently the same young bird was observed on June 22 and 23 being fed by the sparrow. On the 25th the kingbird was still being fed, and on the 26th and 27th it was beginning to catch insects but would light with the sparrows and feed on the bread. The kingbird was not seen after the 27th, and the other two young birds were not seen again. Adult kingbirds were not seen anywhere in the vicinity at any time.—G. Dale Hamilton, *Shreveport, Louisiana, April 23, 1952.*

Pomarine Jaeger and Bonaparte Gull in the Hawaiian Islands.—On the morning of January 10, 1952, while at sea thirty miles from Pearl Harbor, Oahu, Hawaii, I sighted two adult Pomarine Jaegers (*Stercorarius pomarinus*) following the wake of the ship. As we approached closer to land these two were joined by others of the same species. Individuals seemed to stay with the ship for only a few miles, thus making a total count difficult. Eleven birds were seen at one time, of which about one-third were in the adult plumage. The last bird remained with the ship until it was within two miles of the entrance buoy to Pearl Harbor. Conversation with Mr. George Munro of Honolulu indicates that jaegers had not previously been reported from the Hawaiian Islands.

On January 18, 1952, at a sand spit near Kuapa pond on Oahu, I was able to observe a Bonaparte Gull (*Larus philadelphia*) for about one-half hour. The bird was in adult winter plumage and when flushed from a short distance showed no excessive wear on the primaries, nor did it appear to be in an exhausted condition. This species had been recorded only once before from the Hawaiian Islands when a specimen was obtained on Kauai Island on March 14, 1891 (Munro, Birds of Hawaii, 1944: 144).—Robert C. Frohling, *San Francisco, California, April 12, 1952.*

A Case of Avian Tuberculosis in an Immature Avocet.—On March 5, 1951, while observing ducks and shore birds at Point Mugu, California, I found two dead Avocets (*Recurvirostra americana*) lying on the damp mud flats at the edge of the marsh. One was decomposed and had probably died a week before the second bird. The second bird was in fresh condition. Both birds were autopsied. The first showed no signs of pathology. The second Avocet showed a gross picture that resembled a typical infection of avian tuberculosis. There were numerous adhesions consisting of hard nodules about the liver, spleen, and intestinal tract. This bird was extremely emaciated. Bacteriological smears were made and examined by Mr. Wm. W. Blackman and Dr. James J. Short, Director of Internal Medicine, Soto Medical Laboratories in Los Angeles. Acid fast organisms resembling *Mycobacterium avium* predominated in the smears. The presence of these bacteria and the typical gross pathologic picture indicate that this Avocet succumbed to an advanced infection of avian tuberculosis.—William R. Lasky, *Santa Monica, California, July 30, 1951.*

A Hooded Merganser from the Late Pleistocene of Oklahoma.—I have had the privilege of studying a number of small collections of more or less fragmentary fossil bird bones taken from

various localities by Dr. Claude W. Hibbard and his associates. While definite determinations must in many instances await further study, one identification which seems worth placing on record is that of a Hooded Merganser, *Lophodytes cucullatus* (Univ. Mich. Mus. Paleo. no. 24747), from late Pleistocene deposits in Oklahoma. This fossil was taken from deposits laid down in a fresh water basin, the Nye Sink, on the XI Ranch, 21 miles south of Meade, Kansas, in sec. 15, T.6 N., R. 25 E., Beaver County, Oklahoma. These are very late Pleistocene deposits, as described by Smith (Kans. Geol. Surv. Bull., 34, 1940:103-104), containing silt, clay, silty sand, and diatomaceous earth. The stratigraphy in the area is greatly complicated by the formation and filling of a series of sinks and basins, so that the exact determination of the age of beds is extremely difficult. Associated vertebrates include the mammal species *Mammuthus columbi* and *Synaptomys bunkeri* (Hibbard, Univ. Kans. Sci. Bull., 26, 1939:367-371; Contr. Univ. Mich. Mus. Paleo., 7, 1949:79), a small duck, and fish and amphibian remains, although these may belong to a slightly older fauna than does the bird material here discussed.

The merganser remains, a left tarsometatarsus, complete except for the outer trochlea and the greater part of the most medial calcaneal ridge, I found inseparable from those of the series of modern *Lophodytes cucullatus* available for comparison. The fossil is nearly white in color, brittle, but well preserved except for the defects noted. It measures 30.3 mm. in total length and 7.4 mm. in width of head. Four females in the Museum of Zoology of the University of Michigan range from 30.3 to 31.7 mm. in length, and four males from 31.7 to 34.1, indicating that the fossil probably represents a female. The width of the head of the fossil is slightly greater than would be expected, the female specimens examined ranging from 7.1 to 7.4 mm. The fossil is not, however, notably heavier in the shaft, and any difference seems probably attributable to individual variation.

The species has been previously recorded from the Pleistocene from the Itchtucknee River, Florida, and from Fossil Lake, Oregon (Wetmore, Smiths. Misc. Coll., 99, 1940:28).—William A. Lunk, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan, March 3, 1952.*

Bird Notes from Southern Colorado.—The following observations made in southern Colorado, mostly in the San Luis Valley at an average elevation of 7400 feet, represent occurrences of species that have been only rarely or never before reported in Colorado. Unless otherwise noted, all specimens mentioned are now in the collections of the Denver Museum of Natural History.

Casmerodius albus. American Egret. One was seen with three Snowy Egrets (*Egretta thula*) at the Russell Lakes, 10 miles south of Saguache, on April 19, 1950. B. D. Baker saw another American Egret three miles east of Monte Vista, Rio Grande County, on July 8, 1950.

Ixobrychus exilis. Least Bittern. A lone bird of this species was flushed in hardstem bulrush cover at the Russell Lakes, June 7, 1950. It was the only Least Bittern noted in the course of two years' intensive coverage of the area. The American Bittern (*Botaurus lentiginosus*), however, was a very common breeding species.

Falco peregrinus. Duck Hawk. Although rather rare in most parts of Colorado, the peregrine was a fairly common migrant in the San Luis and Upper Rio Grande valleys of Colorado. The writer observed individuals near South Fork on June 8, 1949, at the Russell Lakes on July 30 and August 19, 1950, and at the Rio Grande Reservoir, elevation 10,000 feet, on June 4, 1950. Dr. Paul C. Bibbee saw a Duck Hawk near Creede, Mineral County, on July 2, 1950. Bert D. Baker saw one near Mirage, Saguache County, on September 12, 1950, and another near Del Norte, Rio Grande County, on October 20, 1950. The writer collected an adult female near Mancos, Montezuma County, on July 23, 1950. When collected, the falcon was in a plowed field feeding on an adult male Redhead (*Aythya americana*). The Duck Hawk skin is now in the collections of the Colorado Cooperative Wildlife Research Unit of the Colorado Agricultural and Mechanical College.

Pelidna alpina. Red-backed Sandpiper. One female was collected from a flock of Western Sandpipers (*Ereunetes mauri*) five miles north of Center in Saguache County on May 5, 1950. Niedrach and Rockwell (The Birds of Denver and Mountain Parks, 1939:78) considered this species to be rare in Colorado.

Asio flammeus. Short-eared Owl. Although a common winter resident in Colorado, there are few records of this species nesting in the state (Sclater, A History of Colorado Birds, 1912:199). Niedrach and Rockwell (*op. cit.*: 96) listed it only as a winter resident in the Denver area. In June, 1950, the writer found two nests in low, rush (*Juncus ater*) meadows on the Charles Headlee Ranch approxi-

mately five miles northwest of Monte Vista. An adult female was collected at the Russell Lakes on August 13, 1950. The skin is in the Wildlife Unit's collections.

Melanerpes erythrocephalus. Red-headed Woodpecker. One female was observed eight miles west of Del Norte, Rio Grande County, on October 10, 1951. Niedrach and Rockwell (*op. cit.*: 103) noted that this species was extending its range westward in the Denver area.

Pyrocephalus rubinus. Vermilion Flycatcher. A female was collected at Pearsall's Trout Hatchery on Spring Creek, eight miles south of Monte Vista, Rio Grande County, May 16, 1950. This species has apparently never before been reported in Colorado. Gale Monson's account of seeing a Vermilion Flycatcher near San Antonio, New Mexico, is the northernmost record known for the Rio Grande Valley (Condor, 48, 1946:238-241).

Seiurus noveboracensis. Northern Water-thrush. An adult was taken on May 16, 1950, at Pearsall's Trout Hatchery. Two birds of this species were noted in the same area the following week. Niedrach and Rockwell (*op. cit.*: 142) considered this species a rare migrant in the Denver area and knew of only four Colorado specimens.

Piranga rubra. Summer Tanager. B. D. Baker noted an immature male approximately four miles east of La Garita, Saguache County, which the writer collected on May 15, 1950. According to records in the Denver Museum of Natural History, this is probably the third Colorado specimen of this species. —Ronald A. Ryder, *San Francisco, California, February 3, 1952.*

Confused Enemy Recognition.—Regarding the phenomenon of enemy recognition by birds (Cross, Auk, 67, 1950:512; Davis, Auk, 67, 1950:518; Rand, Auk, 68, 1951:524-525), certain field observations suggest to me that a bird's reaction may be directed not only against a recognized enemy but against any form which resembles an enemy.

On May 26, 1951, Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*) nesting in an extensive cattail marsh southeast of Fort Collins, Colorado, commenced an excited harangue when a high-flying B-29 airplane passed over the marsh. A week later these same birds in a three-hour period harangued a Great Blue Heron (*Ardea herodias*), American Crow (*Corvus brachyrhynchos*), and Common Nighthawk (*Chordeiles minor*) which crossed above the marsh.

Although none of the objects which excited the blackbirds can typically be considered in an enemy status in this locality, there is a decided resemblance between each of the objects and various hawks, especially the Marsh Hawk, which harass the blackbirds. Since it is not uncommon for ornithologists momentarily to mistake some of the aforementioned objects for birds of prey, it is not surprising that the blackbirds appear to err likewise, particularly when under the stress of defending a nest.—Richard G. Beidleman, *Zoology Department, Colorado Agricultural and Mechanical College, Fort Collins, Colorado, March 31, 1952.*

The European Starling in Central British Columbia.—For three years prior to 1948 I saw occasional birds I was sure were European Starlings (*Sturnus vulgaris*) in the vicinity of Williams Lake, British Columbia. However, it was not until April 30, 1948, that a specimen was taken at 150-Mile House in this area. A few weeks later, near the same place, a female starling was seen carrying grasshoppers into an abandoned woodpecker's nest cavity about 30 feet from the ground. It is not known whether the young were raised successfully. Since then I have taken an adult female at Williams Lake on November 26, 1948, another specimen at Williams Lake on April 26, 1951, and a third at Kleena Kleene, 200 miles west of Williams Lake, on October 21, 1951.

A second breeding record was noted in the summer of 1951 when a pair of starlings nested near the Williams Lake stockyards. These constitute the first establishment of the species in British Columbia. —L. Jobin, *Williams Lake, British Columbia, April 15, 1952.*

Golden Eagle versus Red Fox: Predation or Play?—In a paper on mammals of the Brooks Range, Alaska, Rausch (Arctic, 4, 1951:147-195) records two instances of attacks made on red foxes by Golden Eagles (*Aquila chrysaëtos*). Dixon (Jour. Mamm., 14, 1933:257) recorded attacks by an adult eagle on a red and a cross fox in Mount McKinley National Park, Alaska. Adolph Murie (The Wolves of Mount McKinley, National Park Service Fauna Series, 5, 1944:217-218) records several instances of eagles swooping on foxes.

On June 14, 1948, I witnessed an encounter between an immature Golden Eagle and a red fox. I was flying in a Piper Super-Cruiser plane near the mouth of the Colville River, on the arctic coast of Alaska. The pilot first saw the fox and took it to be a wolf. Shooting wolves from small planes, for bounty, is the favorite pastime of Alaskan bush pilots, so he swung the plane around and dove toward the fox. We flew about fifty yards to one side and fifty feet above the running fox, and suddenly an eagle, which we had not seen previously, stooped close to the fox. No blow was seen. As we pulled up and circled, the eagle stooped again and apparently struck, for the fox was knocked over backward into a shallow pond of melting snow water. It may be that the fox fell over backward, for he had arisen on his hind legs in an apparent attempt to snap at the eagle.

As we came around the third time, we saw the eagle sitting on the ground some distance away. The fox was coming at him on a dead run, and the eagle turned to face the fox. At the last possible moment the eagle took off directly over the fox's head. This seemed to end the encounter, as the eagle continued to soar and the fox kept on running.

I do not believe that this was attempted predation on the part of either eagle or fox. There were thousands of Black Brant (*Branta nigricans*), ducks of several species, including Old-squaw (*Clangula hyemalis*), eiders (*Somateria* sp.), Pintail (*Anas acuta*), and others in the vicinity. On land, Willow Ptarmigan (*Lagopus lagopus*) were evident, and the holes of ground squirrels (*Citellus parryi*) were common in the sandy river banks. There was, in short, no lack of available food for either species.

Rausch (personal communication) believed the two cases mentioned by him (*op. cit.*: 171) were attempted predation. Dixon (*loc. cit.*) does not say whether or not he thought the instance he recorded was attempted predation, but the tone of his remarks conveys this impression. Seton (Lives of Game Animals, New York, 1, 1937:506, 539) says that foxes guard against eagles by staying in brush. Eagles take pups from the open near mouths of dens, but even this rarely, because the mother watches too closely. Very rarely is an old fox taken by an eagle, but one such occurrence at Estevan, Saskatchewan, is cited (W. M., Forest and Stream, Feb. 8, 1896:114). A. Murie (*op. cit.*: 217) says that eagles swoop at foxes just as they do at other mammals, including grizzlies. He also cites an instance of an eagle-wolf encounter: "About a dozen times the eagle swooped, barely avoiding the wolf which each time jumped into the air and snapped at it. The eagle turned upward at the right moment to avoid the leap, and apparently was enjoying the game." His examination of 632 eagle pellets disclosed no fox remains, and he believes that instances of fox capture by eagles are exceptional. The chief food of the eagle is the ground squirrel, a most abundant mammal. Eagles take very small numbers of caribou calves (p. 162) and mountain sheep lambs (p. 99), while the bulk of the food is largely composed of marmot, mice, ptarmigan, and small birds, in addition to ground squirrels (pp. 225-229).

Olaus Murie (Condor, 42, 1940:198-202) found blue fox remains only once out of 399 items in 28 nests of the Bald Eagle on the Aleutian Islands. This was a fox pup, and may well have been carrion. Even so, this represents only 0.3 per cent of the eagle food items. He concludes that Bald Eagles are not a serious menace to the blue fox population, as has been alleged.

In short, it appears that cases of actual predation by eagles on foxes must be extremely rare. It is possible that the cases cited above are actually attempted predation. The fact that the encounter I witnessed occurred within view of more easily obtainable food for each participant tends to disprove this, as do Adolph Murie's statements.

Another possibility is that these encounters are a sort of dominance expression between two large and vigorous species. However, it seems likely that these apparent attacks, or some large proportion of them, are entered into in a spirit of play by the eagle, and probably also by the fox.—RAYMOND J. HOCK, *Arctic Health Research Center, Anchorage, Alaska, March 29, 1952.*

An Early Specimen of the Eastern Fox Sparrow from Colorado.—In 1918 (Auk, 35:236), the writer reported what was then believed to be the first record of the eastern race of the Fox Sparrow (*Passerella iliaca iliaca*) in Colorado. The specimen was collected in the Clear Creek valley, six miles west of Denver, on November 1, 1916, by Robert J. Niedrach. It is preserved in the Denver Museum of Natural History.

Recently, while studying Fox Sparrows in the United States National Museum, a Colorado specimen of this race was discovered that antedates the Clear Creek bird by more than 30 years. It was taken at Denver in December, 1884 (exact date not given; U.S.N.M. no. 125,312). The specimen was

received from Rollo H. Beck but was collected by W. T. Strong who, so far as is known to the writer, has had no other part in the ornithology of Colorado.—FREDERICK C. LINCOLN, *Fish and Wildlife Service, Washington, D. C., April 26, 1952.*

Additions to the Check-List of Birds of Grand Canyon National Park, Arizona.—The Check-List of Birds for Grand Canyon National Park, including additions of recent years, lists 179 species and subspecies, of which 15 are water birds. Specimens of birds taken for the Park Museum by Allan R. Phillips in Havasu Canyon, from September 23 to 26, 1950, include five species new to the park, bringing the total to 184. These additions are: Wright Flycatcher (*Empidonax wrightii*); Marsh Wren (*Telmatodytes palustris plesius*); Red-eyed Vireo (*Vireo olivaceus*); Savannah Sparrow (*Passerculus sandwichensis nevadensis*); and Dickcissel (*Spiza americana*). The Dickcissel is the first modern record for northern Arizona. A flock of nearly a hundred Savannah Sparrows was observed by H. C. and Amy M. Bryant just west of Grand Canyon Village on September 12, 1950; a few remained there until October 3, 1950, and later. The Marsh Wren represents the proposed race *pulverius* Aldrich, according to Phillips.

Other species of more than ordinary interest identified by Phillips in Havasu Canyon in September were: Ladder-backed Woodpecker (*Dendrocopos scalaris*), Virginia Warbler (*Vermivora virginiae*), Hermit Warbler (*Dendroica occidentalis*), and Purple Finch (*Carpodacus purpureus*).

In the fall of 1950 there was an extraordinarily conspicuous fall migration. For example, five species of warblers were seen in the same tree (a black walnut at El Tovar Hotel) within one week, September 14-21, 1950: Calaveras, Orange-crowned, Yellow, Audubon and Macgillivray. The Green-tailed Towhee also was a conspicuous and abundant migrant.—HAROLD C. BRYANT, *Grand Canyon, Arizona, February 1, 1952.*

A New Nesting Record of the Cinnamon Teal in Humboldt County, California.—On May 25, 1951, while we were conducting a waterfowl nesting study in Humboldt County, California, a female Cinnamon Teal (*Anas cyanoptera*) was flushed at 10:45 a.m. from a nest containing seven eggs. The nest was situated in a coastal fresh-water marsh composed of nigger head (*Juncus effusus*), and bog rush (*Carex obnupta*). The nigger head was the dominant cover plant with only a fraction of 1 per cent being comprised of bog rush. About 5 per cent of the water surface was open, the balance was closed over with a continuous mat of water buttercup (*Ranunculus* sp.) and smaller duckweed (*Lemna minor*). The nest itself was placed on the south side of a nigger head clump, six inches above the water and was constructed of dead nigger head leaves. Little down was present at the time of discovery. Water, sixteen inches in depth completely surrounded the plant growth containing the nest. A second visit was made to the nest on June 2. At that time the female was flushed again and the nest revealed an increase of three eggs, making a clutch of 10.

This female and her mate were the only Cinnamon Teal observed in the quarter section included in the nesting study. A review of the literature indicates that the Cinnamon Teal seldom nests in the humid coastal belt of California, but frequently is found in the interior (Grinnell, Bryant, and Storer, Game Birds of California, 1918:126; Grinnell and Miller, Pac. Coast Avif. No. 27, 1944:74).—NED DOLLAHITE and MORRIS P. ANDERSON, JR., *Humboldt State College, Arcata, California, July 10, 1951.*

Additional Nevada Bird Records.—There follow some of the more significant items extracted from our notes which supplement Linsdale's recent publication, "A List of the Birds of Nevada" (Condor, 53, 1951:228-248). In addition our personal notes contain many other items of less importance, but which would alter Linsdale's information on the distribution and abundance of some birds within the state, particularly the ducks. We will retain this information until such time that a more extensive report on the birds of Nevada is undertaken.

Chen caerulescens. Blue Goose. This species is not listed by Linsdale. An adult, shot by a hunter at Carson Lake, Churchill County, in December of 1950 is now mounted and on display at the Sagebrush Cafe in Fallon. Hunters report seeing a few of these birds at Carson Lake almost every winter since 1937.

Chen rossii. Ross Goose. This species is not listed by Linsdale. Hunters report seeing occasional geese of this species in Churchill County since 1933 and it is not uncommon for one or more to be

killed each fall. We examined two that were killed at Carson Lake on November 4, 1951. One of these birds was sent to the Charles R. Conner Museum at Pullman, Washington, and the other is to be mounted for display at the Sagebrush Cafe in Fallon. A larger number of these birds than usual turned up in the Fallon area in 1951, when a minimum of five was shot by hunters.

Aythya valisineria. Canvasback. Linsdale did not list this species as breeding. According to unpublished reports and the personnel of the United States Fish and Wildlife Service and the Nevada Fish and Game Commission, it is a common breeding duck at the Ruby Lake Refuge in Elko County.

Clangula hyemalis. Old-squaw. This species has not previously been listed for the state. According to Vernon L. Mills, a mounted Old-squaw at the Oats Park School in Fallon, which we examined, was killed in the 1920's in the vicinity of Stillwater, Churchill County. A more recent specimen present in the Sagebrush Cafe in Fallon was shot at Carson Lake about October 20, 1949.

Perdix perdix. Hungarian Partridge. This species is not listed by Linsdale. It is well established over a wide area in the northern part of the state. Alcorn collected one about 10 miles south-southeast of Denio, Humboldt County, on January 29, 1942. Two others were shot by Vernon L. Mills on April 21, 1942, about 15 miles north of Winnemucca and prepared as specimens by Alcorn. This species has been seen by Alcorn as far south as the southwest side of Smoke Creek Desert in Washoe County and at Kingston Canyon on the east side of the Toyabe Range in Nye County.

Alectoris graeca. Chukar Partridge. Linsdale states: "Reported by Alcorn (1946:132) as resident, not common, in cultivated areas near Fallon." In a later publication, "The Chukar Partridge in Nevada" (Alcorn and Richardson, Jour. Wildlife Manag., 15, 1951:265-275) this bird is reported as now being well established over a large part of Nevada.

Charadrius alexandrinus. Snowy Plover. Evenden (Condor, 54, 1952:174) found the first evidence of this species nesting in the state, a downy young seen at Fernley Sink, Lyon County. On June 19, 1951, Marshall observed an adult snowy plover incubating three eggs at the northeast corner of the Stillwater Marsh, Churchill County. On June 21, 1951, two additional nests, both also with three eggs, were found approximately 100 feet from the former.

Catoptrophorus semipalmatus inornatus. Willet. Linsdale says this bird may breed in Nevada. Alcorn counted seven adults and three young on June 28, 1943, a few miles north of Minden, Douglas County.

Sturnus vulgaris. Starling. We have the following additional locality records. From 2 to 27 were seen by Alcorn from December 14, 1945, to February 21, 1946, on four occasions about 10 miles north of Beatty, Nye County. Twenty-two were seen near Fallon on February 2, 1947. On February 3, 1947, two were collected at this location, one of which is no. 97196 in the Museum of Vertebrate Zoology. They were feeding on Russian olive berries (*Elaeagnus angustifolia*). Starlings were again seen in the Fallon area in the winter of 1948, and since have become more numerous each winter. Flocks totaling up to 200 birds were seen at various locations in the Fallon area in October, November, and December of 1951 by Alcorn, Mills and Marshall. Marshall saw a flock of 50 near Imlay, Pershing County, on November 20, 1951.—David B. Marshall, *United States Fish and Wildlife Service*, and J. R. Alcorn, *Fallon, Nevada, January 10, 1952*.

Willet Eats Jack Smelt Eggs.—On April 4, 1951, at Ocean Beach, San Diego, California, I observed a lone Willet (*Catoptrophorus semipalmatus*) feeding in a shallow salt water pond. This bird was shaking and thereby separating a stringy mass into smaller portions which were then swallowed. This feeding behavior was observed many times with 8 × 30 binoculars at a distance of approximately 40 feet. As the mass was quickly diminishing in size, I flushed the bird, causing it to drop the food. The remaining food was put into a jar of sea water and examined the following day. It consisted almost entirely of fish eggs adhering to a few leaves of Torrey surf grass (*Phyllospadix torreyi*). The mass was somewhat cylindrical in shape with rounded ends and measured 2.5 cm. in diameter and 12.5 cm. in length. The eggs were not viable. They were later identified as those of the jack smelt (*Atherinopsis californiensis*). Within the mass were three immature beach hoppers (*Orchestoidea*) all less than 2 mm. in length and some bits of calcareous algae.

Jack smelt are known to spawn in surf grass found in shallow water along the coast. During heavy surfs, surf grass is commonly cast up on the beach.—Howard R. Attebery, *San Diego, California, April 26, 1952*.

The Generic Name of the White-bellied Wren of Mexico.—Until recently the White-bellied Wren of México was little known as a living entity and was seldom mentioned in the literature. Sutton's account (Condor, 50, 1948:101-112) of its nesting has brought it wider notice. Since the species is likely to figure regularly in future study of the birds of México, it seems desirable, without further delay, to call attention to a nomenclatural change required under the International Rules of Zoological Nomenclature. Since 1904 the White-bellied Wren has gone by the name of *Nannorchilus leucogaster*, the genus being monotypic. Originally the genus was recognized and named *Uropsila* by Sclater and Salvin (Nomencl. Avium Neotrop., 1873:155). Ridgway in 1888 (Proc. U. S. Nat. Mus., 10:511) pointed out that under the practices then current with respect to priority the generic name *Uropsila* was preoccupied by *Uropsilus* Edwards 1871 [1872?], a name for an insectivore mammal, and he substituted *Hemiura*. For similar reasons in 1904 (Proc. Biol. Soc. Wash., 17:102) he substituted *Nannorchilus* for *Hemiura* (preoccupied by *Hemiurus* Rudolphi 1809). Since the International Rules adopted in 1901 do not consider generic names to be identical that differ by but one letter or in the form of ending and since the American Ornithologists' Union Code of Nomenclature has been changed in this particular (Auk, 64, 1947:445) to coincide with the International Rules, *Uropsila* should not be rejected and thus appears to be the valid generic name for this wren.

Monotypic genera that are but slightly differentiated morphologically have little to recommend them, and *Uropsila leucogastra* might appropriately be investigated to see if it does not belong in another genus. However, Sutton's review (*op. cit.*) of this matter both on the basis of habits and structure and my own partial examination of the characters of *Uropsila* lead to no clear conclusion regarding the closest relatives among other wrens. Until it becomes certain which group of wrens the White-bellied Wren should be merged with, the species may properly be referred to as *Uropsila leucogastra* (Gould).—Alden H. Miller, *Museum of Vertebrate Zoology, Berkeley, California, September 5, 1952.*

NOTES AND NEWS

W. Lee Chambers in his Cooper Club office and library at his home in Eagle Rock in the late 1920's.

The members of The Cooper Ornithological Club are pleased to dedicate this special issue of The Condor to W. Lee Chambers.

For nearly fifty years he has devoted much of his time to the affairs of the Club with such friendliness, optimism, and tenacity of purpose that the business interests of the Club and its journal have been personified in Lee Chambers. The favorable financial position of the Club today together with its large membership is a high tribute to his intensive efforts.

We trust that his time of inactivity will be lightened for him by the recollection of the many friends he has made and the inspiring record of service he has set through the years.

The value of his faithful labor is known to all who read The Condor and it is with great pleasure that we dedicate this issue to "Mr. Cooper Club," W. Lee Chambers.—C. V. DUFF.

The painting by Allan Brooks reproduced in this issue has kindly been made available by its owner, Oliver N. Wells of Sardis, British Columbia. It has not been published heretofore. Captioned "Warden of the Arctic," it depicts a Gyrfalcon (*Falco rusticolus*) on the tundra of an arctic sea coast. The painting was made in 1926 for the Brooks home and remained there until 1946.

The Proceedings of the Tenth International Ornithological Congress held in Uppsala, in June 1950, is now available for purchase from Professor Sven Hörstadius, Zoologiska Institutionen, Uppsala, Sweden. Book dealers may order it from Almqvist and Wiksell, Uppsala, Sweden. The price is 35 Swedish crowns ($6.75 U. S.).

The volume covers the proceedings of the Congress, and some 83 papers presented before the meetings under four main headings: Evolution and Systematics, Migration and Orientation, Behavior, and Regional Faunas. The book is paper bound, in attractive form, with 662 pages (531 in English, 28 in French, 93 in German), 1 color plate, 30 photographs, 125 maps and diagrams, and 46 tables. The edition includes only copies for the members of the Congress and a small number in addition for sale. Those interested in purchasing should order without delay as the number available is limited.

Through an unfortunate error, the recent membership list of the Cooper Ornithological Club incorrectly indicated the year in which William B. Sampson joined the organization. The year should be 1894, as correctly stated at the time Mr. Sampson's photograph was presented in 1948 (Condor, 50:136). It is a pleasure to acknowledge his membership of 58 years' standing, a period equaled or exceeded by only three others among our current members.

Howard L. Cogswell has taken a position as Assistant Professor in the Biology Department at Mills College, Oakland, California, and Keith L. Dixon has joined the staff of the Department of Wildlife Conservation, as Assistant Professor, at Texas Agricultural and Mechanical College, College Station, Texas. Both men have served skillfully and faithfully as Assistant Editors of the Condor.

COOPER CLUB MEETINGS

NORTHERN DIVISION

JUNE.—The monthly meeting of the Cooper Ornithological Club was held on June 5 at the University of California, Berkeley. The following names were proposed for membership: Enid A. Larson, Carmel, Calif., by Jean M. Linsdale; Carlyle Sather, San Francisco, Calif., by Junea W. Kelly; Larry E. Chapman, Oakland, Calif., by C. V. Duff; Mrs. John Brecher, Berkeley, Calif., by Robert I. Bowman; Robert Winter, Fresno, Calif., by Henry Childs; Sterling Bunnell, Jr., San Francisco, Calif., by R. T. Orr. The following names were unanimously approved for honorary membership in the Club: Walter K. Fisher and Clark P. Streator. Dr. Alden H. Miller announced that the Cooper Ornithological Club is being asked to participate in the Annual Meeting of the American Association for the Advancement of Science, to be held in the San Francisco Bay area in 1954.

Mr. Wilbur W. Mayhew, Division of Zoology, University of California at Davis, spoke on the nesting habits of the Cliff Swallow in central California.—ROBERT I. BOWMAN, *Secretary*.

GOVERNORS' MEETING

The twenty-seventh Annual Meeting of the Board of Governors of the Cooper Ornithological Club was held in the California Room of the Hotel Whitcomb, San Francisco, California, on May 9, 1952. President Frank A. Pitelka called the meeting to order at 8:00 p.m. with the following members present: Robert I. Bowman, Herbert L. Coggins, Keith L. Dixon, C. V. Duff, Wade Fox, Junea W. Kelly, Eric C. Kinsey, Jean M. Linsdale, Alden H. Miller, Robert C. Miller, Robert T. Orr, J. R. Pemberton, Frank A. Pitelka, Eric Reynolds, Charles G. Sibley, and Kenneth E. Stager. Guests present were: Hilda Grinnell, Lois Taylor, and Robert W. Storer.

The report of the Business Manager was submitted by Mr. C. V. Duff. Some of the points noted were as follows: The Avifauna Fund contains a balance of $236.90; the Grayson Plate Fund, $99.92. Net Avifauna sales for the past year were $1,446.57 and sales of back issues of the Condor totalled $904.15. The present total membership is 1432 and the total Condor circulation (members plus subscriptions) is 1710. There are 184 sustaining memberships.

Mr. Duff reported for the Auditing Committee. Sherwin F. Wood and Vernon Barret, who had checked the stock held by the Club, were the members of the committee. Mr. Kinsey moved that the Governors request the Directors to give consideration to the employment of an auditing firm at a cost not to exceed $150.00 per annum, said firm to render a monthly statement to the Business Manager and the Board of Directors. The motion was seconded by Mr. Pemberton and unanimously passed.

The report of the Editors for 1951 was presented by Dr. Miller. For 1951 the Condor published 320 pages, an increase of 32 pages over 1950. In 1952 a volume of the same size is anticipated with two special issues: (1) The January-February issue containing Williams' Brewer Blackbird paper and (2) later in the year the issue honoring Mr. W. Lee Chambers. Seventeen Grayson plates have been printed to date and in 1951 the printing of exceptionally good bird photographs was started. More of these are needed. The aid of editors' wives and the help of Richard Johnston and Lois Taylor was acknowledged.

Dr. Miller read a letter from Sidney B. Peyton submitting his resignation as Treasurer. Mr. Duff moved that the Board of Governors accept the resignation and thank Mr. Peyton for his services as Treasurer. The motion was seconded by Mr. Kinsey and unanimously passed.

Mr. Duff moved that the present officers of the Board of Governors be re-elected. The motion was seconded by Mr. Pemberton and unanimously passed.—CHARLES G. SIBLEY, *Secretary*.

Concerning Cooper Club Memberships and Subscriptions
Address C. V. DUFF, Business Manager,
1922 Tamarind Avenue, Hollywood 28, California

Send dues, address changes, and advertisements to
Jack C. von Bloeker, Jr., Treasurer,
161 West 121st St., Los Angeles 61, California

For Sale, Exchange, and Want Column—Each Cooper Club member is entitled to one short advertising notice in any issue of the Condor free. Notices of over 3 lines will be charged for at the rate of 25 cents per line.

WANTED—Bird Song, by Aretas A. Saunders, New York State Museum Handbook 7, Albany, 1929. —WILLIAM R. FISH, *302-B Entwistle St., China Lake, Calif.*

FOR SALE—California Traveller and Naturalist, 1893, odd nos.; The Avifauna, 1893; Natural Science Journal, 1897; Nidologist, 1894; Journal, Museum Comparative Zoology, 1919; Comparative Oologist, 1924; Museum Work, 1919; The Heron, 1930-32; The Museum, 1894-96; Osprey, 1896-97 (complete); Bird Lore, 1931-38 (complete); Proceedings Biological Society Washington, 1911-17 (complete); make offer.—STANLEY G. JEWETT, *1404 S. E. Bidwell St., Portland 2, Oregon.*

WANTED—Vol. 3, no. 2, Journal of Mammalogy (to complete a set); please state price.—W. B. QUAY, *University of Michigan Museum of Zoology, Ann Arbor, Mich.*

WANTED—Contributions or donations of moderately fresh (non-weathered) owl pellets of all species in quantity; please correspond before making shipments.—JACK C. VON BLOEKER, JR., *Division of Natural Sciences, Los Angeles State College, 855 N. Vermont Ave., Los Angeles 29, Calif.*

WANTED—Journal of Wildlife Management, vols. 3 and 4; Transactions of the North American Wildlife Conferences, 1 to 9; also any American Game Conference Transactions.—GORDON W. GULLION, *624 Avenue I, Boulder City, Nevada.*

PREPARATION OF MANUSCRIPTS FOR THE CONDOR

Articles published in the Condor normally are written by members of the Cooper Ornithological Club. Practically all the Club's money goes into the journal; no editor or business manager receives any pay other than the satisfaction of doing a service worthily. The preparation of good copy by the author will contribute greatly to accuracy of published output, dispatch in handling, and economy of production.

To be acceptable for inclusion in the Condor, articles must not duplicate in any substantial way material that is published elsewhere. Any type of subject bearing on birds may be considered; but the geographic areas of primary concern are western North America, Central America, and the Pacific Basin. Manuscripts may be sent to the editors at the Museum of Vertebrate Zoology. Proofs with edited manuscripts will be sent to authors, at which time reprints may be ordered.

In the interests of accuracy and economy, observe the following: do not duplicate data in text, tables, or charts; check citations to original sources and verify text references; quoted statements must be exact replicas of the original; preferably use vernacular names applicable to the entire avian species (for a guide in this regard, see "The Distribution of the Birds of California," Pac. Coast Avif. No. 27, 1944:5-34); in general, avoid subspecific vernaculars; insert scientific names for species but not the subspecific name except in taxonomic papers or where the race concerned has been critically determined by the author or his collaborators; revise the manuscript repeatedly to remove superfluous words and phrases, immaterial detail, and repetitious statements.

Note Condor style and usage. "General Articles" and the "Field and Study" items are set up in different form. Provide a concise, meaningful title, and, where needed, subtitles within the text. Footnotes are not used. The address line may serve to indicate institutional connection, and to it should be added the date of transmittal of the manuscript. Terminal bibliographies are desirable where five or more titles are to be cited; otherwise, the references may be included in the text. For bibliographic style, note closely the practices employed in recent volumes of the journal. A factual summary is recommended for longer papers.

Rules for copy.—(1) Typewrite material, using one side of paper only; (2) double space *all* material and leave liberal margins; (3) use $8\frac{1}{2} \times 11$ inch paper of standard weight (avoid onion skin); (4) carbon copies are not acceptable; (5) place tables on separate pages; (6) number pages in upper right hand corner.

Illustrations.—Photographs should be glossy prints of good contrast. Make line drawings with India ink; plan linework and lettering for at least ½ reduction; do not use typewritten labels on the face of the drawing. Provide typed legends on separate sheets.

Helpful references on writing: Manual of Style, University of Chicago Press, and Rules of the Editorial Committee, University of California Press. On scientific nomenclature: A.O.U. Check-list (with supplements 19 through 26) and Pacific Coast Avifauna No. 27; authors are not required to follow either of these works.

THE EDITORS OF THE CONDOR.